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ABSTRACT

This book contains 45 activities suitable for use in secondary science and social studies classes. Except for the first four activities, which are quick attention getters, all the activities are presented in a standard format. Each begins with an introduction, that provides a brief overview of the activity's content and the teaching strategies used. Student learning objectives are listed, as are recommendations for the subject and grade level at which the activity can be used. The time required to use the activity is given, and any materials and preparation needed are described. Step by step procedures are presented. Included are questions that can be used to stimulate discussion, probe the issue, or debrief a discussion or other activity. Finally ideas for extension and enrichment are given. In some cases, additional resources that could be used to enhance learning about the lesson topic are listed. The activities are organized into three major sections. First are starter activities that stimulate awareness about science, technology, society (STS) topics on issues and help students brainstorm, generate discussion, and explore ideas about STS issues. The following two sections present lessons designed primarily for science and social studies classes, respectively. Within each section, the lessons are grouped by common course titles. In one, the science courses used are earth science and environmental studies, life science and biology, chemistry, and physics. In the next section, the social studies courses used are world geography, world history, U.S. history, and civics and government. (Author/DK)

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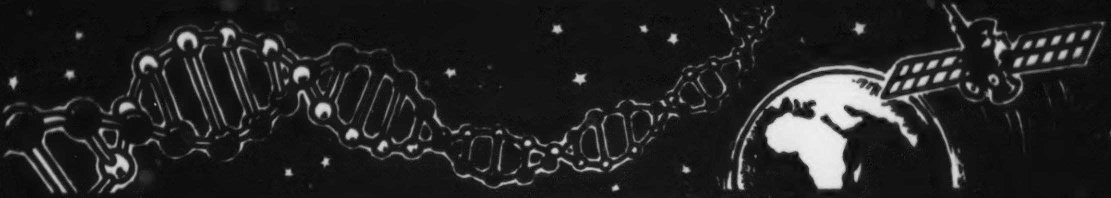

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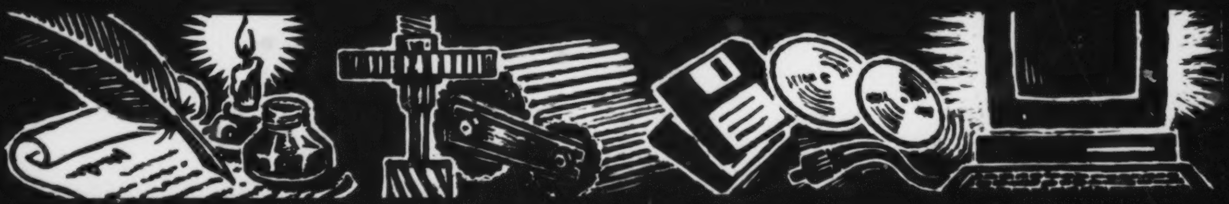

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Activities and Resources for Secondary Science and Social Studies

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Edited by Laurel R. Singleton

Social Science Education Consortium

Science/Technology/Society:

Activities and Resources for Secondary Science and Social Studies

Edited by Laurel R. Singleton

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I. INTRODUCTION

Importance of Education on Science/Technology/Society

Modern societies, such as the United States, are increasingly propelled and changed by advances in science and technology—distinct and synergistic ways of knowing about and altering the world. Sciences (processes of knowing about nature and society) and technology (ways of adapting the environment to satisfy human needs and wants) are combined in modern societies to provide increasing human control over natural and social environments. Tremendous, ongoing achievements have spawned great hopes, fears, and controversies.

In a democracy, citizens have the right and responsibility—as voters, consumers, workers, and office holders—to participate in decisions about issues related to social uses of science and technology. The success of individuals and their society is tied to the quality of these choices, which varies with the knowledge and cognitive skills of decision makers. The vitality of our American democracy depends upon widespread ability of citizens to think effectively about developments in science and technology and their effects on the world. Therefore, a central mission of American schools should be education on science and technology in a social context.

Leaders in social studies and science education have recognized the importance of science/technology/society (STS) education for a number of years. The National Council for the Social Studies devoted a yearbook to STS in 1956 (Cummings 1956-57). In the past ten years it has adopted and revised curriculum guidelines for STS education in social studies (Science and Society Committee 1990). The social studies curriculum standards include one standard devoted to STS (Marker 1993).

Similarly, the National Science Teachers Association has, over the past 15 years, issued a position statement on STS (National Science Teachers Association 1982) and published a yearbook on the topic (Bybee 1985). Curriculum standards in science also include the STS theme. Certainly, the curriculum reform efforts of the American Association for the Advancement of Science have emphasized interactions between and among science, technology, and society (AAAS 1989).

The calls for reform give major responsibility for education about social issues related to science and technology to teachers. Teachers must rethink the role they play in the development of STS education, particularly in reflecting the constant shifts in values, the need for an increased knowledge base, and the implementation of processes that convey knowledge while including students in active, participatory learning. This book is designed to provide instructional models and inspiration to teachers undertaking this important work.

Content and Organization of This Book

This book contains 45 activities suitable for use in secondary science and social studies classes. Except for the first four activities, which are quick "grabbers," all the activities are presented in a standard format. Each begins with an **Introduction**, which provides a brief overview of the activity's content and the teaching strategies used. Student learning **Objectives** are listed, as are recommendations for the **Subject and Grade Level** at which the activity can be used. The **Time Required** to use the activity is given, and any **Materials and Preparation** needed are described. Step-by-step **Procedures** are presented; included are questions that can be used to

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stimulate discussion, probe the issue, or debrief a discussion or other activity. Finally, ideas for **Extension and Enrichment** are given. In some cases, additional **Resources** that could be used to enhance learning about the lesson topic are listed.

The activities are organized into three major sections. First are "starter" activities that stimulate awareness about STS topics or issues and help students brainstorm, generate discussion, and explore ideas about STS issues. Many of these activities are short and easy to use, requiring minimum preparation and disruption from the regular curriculum. Others require a bit more time to use and are thus most effective as introductions to longer STS units.

The following two sections present lessons designed primarily for science and social studies classes, respectively. Within each section, the lessons are grouped by common course titles. In Section III, the science courses used are earth science/environmental studies, life science/biology, chemistry, and physics. In Section IV, the social studies courses used are world geography, world history, U.S. history, and civics/government; in addition, activities in a section on current events can be used in any class in which the teacher devotes time to contemporary issues, including science classes. Because activities can clearly be used in more than one course, the matrix following this introduction shows the STS issue covered in each activity, alternative courses in which the activity can be used, and the primary teaching strategies used.

The activities require anywhere from one class period to one week to complete. They can be included in science or social studies courses to help enrich the existing curriculum materials and provide an STS focus. The lessons employ a variety of teaching strategies, including case studies, role playing, debates, discussion groups, decision-making, simulations, small-group work, data analysis, and so on.

The final section of the book is a resource listing. It includes curriculum materials, as well as organizations that can provide materials or other assistance in developing STS lessons or units.

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PLANNING MATRIX

Lesson	STS/Issue/Topic	Science Courses	Social Studies Courses	Teaching Strategies
1. Mobiles in the Classroom	Adaptable to any issue	Any	Any	Analyzing quotes, making mobiles
2. Technology Mind Walk	↓	↓	↓	Brainstorming
3. STS Scavenger Hunt	↓	↓	↓	Scavenger hunt
4. Voting with Your Feet	↓	↓	↓	Human continuum, discussion
5. Reaction Statements Warm-up	↓	↓	↓	Paired discussion
6. Global and Local Issues	↓	↓	↓	Surveying, data analysis, discussion
7. Science and Technology in the News	All issues; science and the media	↓	↓	Media analysis
8. Will the Real Scientist Please Stand Up?	Stereotypes of scientists	↓	↓	Drawing, discussion, community resource people
9. The Technology Tree	Effects of technologies	↓	↓	Discussion, creation of graphic representations
10. Ten Inventions That Changed Our Lives	Effects of technologies	↓	↓	Worksheet, discussion, writing

Lesson	STS/Issue/Topic	Science Courses	Social Studies Courses	Teaching Strategies
11. Soil Deterioration	Erosion, loss of productive soil	Earth science; general science; environmental studies; biology	World geography	Field study, policy analysis, simulated hearing
12. Land Use	Effects of land use decisions	Life science; earth science; general science; environmental studies; biology	Civics	Role play
13. Energy, Atmosphere, and Climate Change	Air pollution, ozone depletion, global warming	Earth science; physical science; environmental studies	World geography; civics; current events	Data analysis, reading, discussion, problem solving
14. Analyzing Cartoons on the Environment	Various environmental issues	Life science; earth science; environmental studies; biology	Current events	Cartoon analysis and creation
15. John Muir: The Individual and the Environment	Human impact on the environment	Life science; earth science	Geography; U.S. history	Reading, discussion, writing
16. Experimenting with Overpopulation	Effects of overpopulation	Life science; environmental studies	Geography	Simulation, discussion, lab activity
17. The Benefits of Technology: Conquering Diseases	Health-related research, technology and disease	Biology; chemistry	World history; current events	Case study analysis
18. Genetic Screening	Genetic screening	General science; biology	Current events	Decision-making exercise

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Lesson	STS/Issue/Topic	Science Courses	Social Studies Courses	Teaching Strategies
19. What's in the Classroom Air?	Air pollution	Physical science; environmental studies; chemistry	Current events	Data collection and analysis; discussion
20. It's a Natural!	Food additives	Life science; physical science; chemistry	Current events; economics	Brainstorming, categorizing, analysis of labels, reading, discussion
21. Greenville's Garbage	Solid waste disposal	Earth science; physical science; biology; environmental studies; chemistry	Civics; government; current events;	Personal inventory, discussion, case study, writing
22. Pesticides: A Global Problem	Pesticides, pollution	Physical science; biology; environmental studies; chemistry	World geography; economics; current events	Brainstorming, reading, discussion
23. Designing Sustainable Technologies	Technology's impact on the environment, evaluating technology	Physical science; physics	World geography	Evaluating technologies, designing technologies
24. Energy Resources	Use of energy, energy policy	Physical science; environmental studies; physics	World geography; government; economics; current events	Data analysis, discussion
25. What If...?	Effects of scientific understandings on everyday life	Physics		Reading, discussion, small-group work, presentations
26. What Science Should Be Done...And Who Decides?	Funding for science	Physics; can be adapted to any high school science course	Government; current events	Free-writing, small-group work

Lesson	STS/Issue/Topic	Science Courses	Social Studies Courses	Teaching Strategies
27. A Resource Use Warm-Up	Resource extraction and environmental preservation	Earth science; environmental studies	World geography; U.S. history; economics	Simulation
28. Where Have All the Farmers Gone?	Changes in agriculture	Earth science; life science	World geography; U.S. history	Simulation, resource person
29. Introduction to the Global Environment: The Balance of Nature	Ecosystems, human impact on the environment	Earth science; environmental studies	World geography	Reading, discussion, small-group research and problem solving
30. The Ocean Resources Game	Law of the sea	Earth science; environmental studies	World geography; government	Role play
31. Furrows to the Future	Agricultural technology	Life science	World history; world geography	Visual analysis; creation of posters
32. The Industrial Revolution in Japan	Effects of industrialization on society, technology transfer		World history	Analysis of source material, discussion
33. God and the Alarm Clock	Technology and values		World history	Analysis of source material, discussion
34. The Effects of Individual Actions on Technology and Society	Space technology, atomic weapons	Physics	World history; U.S. history; government	Decision tree
35. Inventions Today and Yesterday	Effects of cotton mill; externalities		U.S. history	Brainstorming, analysis of inventions, reading, discussion, creating toys

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Lesson	STS/Issue/Topic	Science Courses	Social Studies Courses	Teaching Strategies
36. Renewable Energy and the American Age of Wood	Decisions about use of energy sources		U.S. history; economics	Lecture, small-group decision making exercise
37. Machine and Social Change in America	Effects of industrialization on society		U.S. history; economics; sociology	Simulated legislative hearing
38. Bad Blood: The Tuskegee Study of Untreated Syphillis	Racism's effect on science	Biology	U.S. history	Human continuum, small-group discussion, decision making
39. Preparing Environmental Impact Statements	Environmental impact statements	Environmental studies; biology	Civics; geography; economics	Preparing environmental impact statements, simulated hearing
40. The Environment and Participatory Democracy	Role of government agencies and special-interest groups in shaping and policy	Ecology; environmental studies	Civics; government; current events	Community resource person
41. First Amendment Rights and Technology	Effects of technology on rights	Physical science	Civics; current events	Research, creating posters
42. Warning Future Generations	Nuclear waste	Environmental studies; physics	Current events; world geography; government	Designing a monument and symbolic languages
43. Violence and the Brain: Can (and Should) We Find the Roots of Aggression?	Violence and genetic research	Biology	Current events; civics; government	Reading, free writing, discussion, pro se court
44. Televisions: Issues vs. Image	Television's impact		Current events; civics; government	Analysis of television news, discussion
45. Junk Science and Juries	Scientific evidence in court cases	Any high school science course	Current events; civics; government	Discussion; small-group work

II. INTRODUCTORY ACTIVITIES

1. MOBILES IN THE CLASSROOM

Quotes can stimulate student interest in a subject that is not immediately intriguing, especially if the quotes are funny. One way to spark students to think about STS issues is by making (or having them make) mobiles of quotes about a particular STS issue and then using the quotes in a variety of ways. For example, you can simple leave the mobiles up in the classroom and discuss them as students ask about them. Usually, one student will ask a question about a particular quotation and that will lead other students to ask questions.

You can also have each student pick a mobile for which he/she will write an explanation. Students should be given time (one week) to write these explanations, allowing them to do additional research if they wish. This strategy can be used as a nonthreatening evaluation tool for a unit on a particular STS issue.

Students can find other quotes or make up their own. These can be made into mobiles and added to the ones already displayed. If mobiles are not appropriate for some reason, quotes can be displayed on mini-banners (perhaps computer-generated) or a graffiti board.

The following are examples of quotes for a unit focusing on population:

- ZPG is like hitch-hiking; you know you'll get there, the only question is when and how.
- 1 + 1≠ 2 in many families.
- What makes you different from anybody else? It's probably the genes you're wearing.
- Spaceship earth—a finite system.
- Population explosion - fact.
- Population crisis - opinion.
- Quality vs. quantity—a crucial concern.
- Will the stork pass the plow?
- Will the baby boom boom?
- There are so many people in the world that God cannot appear to them except in the form of food.
- Growth for growth's sake is the philosophy of the cancer cell.

Adapted from *Teaching About Population Issues* (Denver, CO: Center for Teaching International Relations, 1983). Reprinted by permission of the publisher. Activity developed by George Otero.

2. TECHNOLOGY MIND WALK

A strategy for getting students to think about the pervasive effects of technology is the technology "mind walk." Ask students to mentally review everything they have done since they got up this morning. As they think about their activities, they should notice the different technologies they used in the activities. Construct a class list of all the technologies used. As with any brainstorming activity, do not quit when students first "run down." Instead, ask some probing questions to get them started again.

When students have compiled a lengthy list, ask them what this list shows about the effects of technology on our lives. Are most of the technologies they mentioned helpful? Can they identify any on the list that have harmful effects as well?

Introduce students to the objectives related to technology that your upcoming lesson, unit, or course will address. If compatible with these objectives, you may want each student to choose one technology from the class list and conduct research on how it was developed, the risk involved in its development, the benefits it has created, and any costs involved with the technology.

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3. STS SCAVENGER HUNT

Scavenger hunts can be used to stimulate interest in a topic, as well as to demonstrate to students how widespread the influence of a particular scientific or technological development is. Scavenger hunts work best if students work in groups of from three to five. Before setting out on the hunt, students should be acquainted with the basic rules: If it belongs to someone else, you must get permission to take it. Be sure to find out if the object must be returned. If so, be sure to return it.

The scavenger hunt should consist of a list of items related to a particular topic. Students are to find as many of the items or pictures of the items as they can within a given time period. For example, before beginning a unit on the benefits and costs of space travel, you might compile a list of everyday items developed as spin-offs from the U.S. space program. These might include the following items:

- Survival blankets, tanning blankets, or home insulation of metallized mylor
- Electronic watch or home computer using a microchip
- Cable TV listings or picture of a satellite dish (representing NASA satellites)
- Any item with Velcro
- Heart monitor
- Improved bowling balls
- Antifogging spray

As an alternative, the hunt could ask for signatures of people with specified characteristics. For example, the list below could be used for a scavenger hunt on biomedical technology:

- A person who carries an organ donor card
- A person who has protested use of animals in medical research
- A person who works in the health care industry
- A person who has written a living will
- A person who supports surrogate motherhood
- A person who knows someone who was kept alive on a respirator

A similar list could be developed for nearly any STS issue.

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4. VOTING WITH YOUR FEET

The purpose of the human continuum strategy is to have students choose positions on an issue, defend those positions, and listen to other viewpoints. The strategy allows for greater kinesthetic activity than most issues-based discussions, which gives some students greater freedom to express themselves. The strategy also reinforces the idea that it is okay to change your mind.

To use the activity, define the issue to be discussed in such a way that there are two clearly conflicting options to be considered. Write each position on one of end of a long line you have drawn across the chalkboard. For example:

Scientists today should not
use Nazi data under any
circumstances.

Scientists today should use
Nazi data if it helps advance
knowledge.

Open the discussion by presenting the issue. Then tell students that they are going to express their opinions on the issue by voting with their feet. Ask students who agree with the statement at one end of the continuum to come to the front of the room and stand by the statement; those who agree with the other statement should stand at the other end of the continuum. Those who have positions between the two extremes should position themselves along the line to show their relative disagreement/agreement with the two statements. For example, someone who thinks that Nazi data can be used if the scientist includes a disavowal of Nazi methods might position himself/herself near the midpoint. People who do not know what their position is can stand in a location off the line. Tell students they can change their vote at any time by moving.

Ask for a volunteer near one end of the line to explain his/her position; allow time for someone with the opposing view to respond. Then allow students to question each other regarding their positions. It is a good idea to have some probe questions prepared in case students do not come up with questions or comments quickly. A strategy that is often helpful is to ask the people in the "Unsure" category what they need to know before they can decide which position they would support.

Continue the procedure until the comments appear to be winding down. Allow students to return to their seats. As an evaluation of how well students listened to each other, you might ask them to briefly describe the most effective arguments they heard on behalf of each position.

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5. REACTION STATEMENTS WARM-UP

Introduction:

One way to interest students in STS is to give them an opportunity to discuss and defend their personal opinions regarding current STS issues. This activity will stimulate a great deal of discussion and raise many topics that can be addressed in study units that follow this introduction.

Objectives: Students will be able to:

1. List a variety of current science and society issues.
2. Discuss and defend their positions on these issues.
3. Respect diverse opinions on these complex issues.

Subject/Grade Level: Any secondary social studies or science course

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 5-1 for all students.

Procedures:

1. Distribute the handout. Explain that students are to read each item, then decide whether they agree or disagree. They should also think about the reasons for their positions.

2. When students are finished, they are to pair up and compare answers. For each statement where the positions differ, students must try to convince their partner to change his/her mind. If time allows, let discussion continue until the pair is in agreement on as many items as possible. If time is limited, set a maximum time, perhaps ten minutes. As pairs reach agreement, they should join with other pairs of students and repeat the discussion process with the new groups of four.

3. Continue this doubling up process until the class is in two large groups. Allow a few minutes for discussion in these large groups and then call the class to attention. Go through the items one at a time to gauge student positions. Ask individual students to explain their reasoning for each item. How do these issues and positions reflect/affect our society? World society? What are the "right" answers? How do we find them?

Extension/Enrichment:

Encourage students to begin an STS notebook or journal, using one of the statements from the worksheet as a springboard for their first entries.

Developed by Robert D. LaRue, Jr., Boulder Valley (Colorado) Public Schools.

REACTION STATEMENTS WORKSHEET

Check whether you agree or disagree with each of the following statements. Think carefully about why you feel the way you do. When you have finished, find another student who has finished and compare answers. Discuss your answers and try to reach agreement on each of the items. Try to convince your partner of the correctness of your own position, but also listen carefully to your partner's ideas.

Agree Disagree

_____ _____ 1. Disease, abortion, wars, murder, famine, accidents, and pollution REDUCE the world's population; its INCREASE is promoted by parenthood, medicine, public health, peace, law and order, scientific agriculture, accident prevention, and clean air. Therefore, the population explosion is desirable.

_____ _____ 2. Genetically engineered plants and animals could harm the environment. Development of such new lifeforms should be halted.

_____ _____ 3. The United States should develop a supersonic transport plane (SST)—a commercial plane that goes faster than the speed of sound—to compete with the Europeans, whose SSTs are now in commercial use.

_____ _____ 4. High school football, power mowers, and mountain climbing take more lives each year than nuclear power plants. Therefore, they should be abolished before nuclear power plants are.

_____ _____ 5. No money should be spent trying to wipe out the Med fly, gypsy moth, or other pests that are unusually numerous in a particular year.

_____ _____ 6. Putting fluoride in the public drinking water reduces cavities in your teeth, but it is medication without your consent and should therefore be stopped.

_____ _____ 7. The rich coal beds that underlie some of the most fertile wheat-growing land in the American west should be strip mined.

_____ _____ 8. There should be laws against (a) trail bikes and dune buggies on public lands because they destroy fragile plants and the peace and quiet and (b) loud motorcycles on public highways.

_____ _____ 9. Science will solve such social problems as crime, hunger, and mental illness.

_____ _____ 10. Members of Congress should be required to show that they have had (and passed) some high-school-level science courses before they take office.

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6. GLOBAL AND LOCAL ISSUES

Introduction:

As future decision-makers, students will have to deal with many local and global problems. Even as teenagers, students have the capacity to affect both local and global issues. Learning about and understanding public sentiment regarding such issues can help students put their own values into perspective.

In this lesson, students survey other students, teachers, family members, and members of the community to determine how important they think various issues are. The class then tallies the results of the survey to determine the overall priorities of the people surveyed. They discuss why these priorities are similar to or different from their own priorities.

Objectives: Students will be able to:

1. List at least 15 local and/or global issues.

2. Recognize how these issues affect them personally.

3. Gather information through a survey.

4. Evaluate the results of the survey.

5. Value individual differences and priorities.

6. Appreciate the contribution they can make in solving local and/or global problems.

Subject/Grade Level: Any secondary science or social studies course

Time Required: 2 class periods over 3 or 4 days

Materials and Preparation: Make enough copies of Handout 6-1 for each student to have three copies. Prepare a list of all the issues on the handout on the chalkboard or on poster paper. This will be used in tallying the survey responses.

Procedures:

1. Give each student three copies of Handout 6-1. Review each item on the survey so students understand why the issue is included. Ask students to complete their own surveys individually.

2. Tell students that analyzing their responses to the survey would give an accurate picture of the class's views on the importance of these issues. Would it give a good picture of the general public's views? Why or why not? How could students improve their ability to draw conclusions about the general public's views?

Developed by Janice V. Pearson, Northglenn, Colorado.

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3. Tell students that as a homework assignment, they are to find two other individuals to complete the survey. Before students begin the survey, you may want to inform them of a few basic rules of survey etiquette: (1) they should explain that they are taking a brief poll about people's opinions on local and global issues, (2) they should ask if the person has time to complete the survey, and (3) they should thank the person when they are finished.

4. Allow students two or three days to complete this task. On the day the homework is due, have students report their own responses as well as the responses from the other participants. As students report, tally the responses on the chalkboard or poster paper list.

5. Review the rankings. Using only the responses in the "Major Problem" category, rank order each item. Have students rank order those issues they personally rated as "Major Problems." Discuss how the overall rankings are similar to or different from their own rankings. Ask students to suggest reasons for differences.

6. Next, look at the global issues and the local issues. Ask students:

- What differentiates the two categories?
- How can students personally affect local issues?
- How can students personally affect global issues?
- Since not all who completed the survey ranked the same items as major problems, what does this tell us about individual values and concerns?

7. Ask each student to determine the one issue on the list he/she feels is most important. Then ask students to write a paragraph or two on why this issue was ranked number one and how the student feels he/she could help solve this problem. Students should be graded on how well they defend their choices.

Extension/Enrichment:

Choose four or five items that are ranked as "Major Problems" by the majority and have teams of students research and report on the issues.

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GLOBAL AND LOCAL ISSUES

		Major Problem	Minor Problem	Not a Problem
1.	Crime in my community			
2.	World population growth			
3.	Unemployment in my community			
4.	Air pollution			
5.	Public transportation			
6.	World hunger			
7.	Day care for children			
8.	Quality of education			
9.	National debt			
10.	Threat of nuclear war			
11.	Adequate housing			
12.	Adequate police protection			

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		Major Problem	Minor Problem	Not a Problem
13.	Health care costs			
14.	Care for the elderly			
15.	Worldwide availability of potable water			
16.	Land use			
17.	Nuclear reactors			
18.	Recreational facilities			
19.	Hazardous substances (toxic chemicals, waste dumps)			
20.	Extinction of plants and animals			
21.	Water pollution			
22.	Energy shortages			
23.	Human health and disease			
24.	Litter			

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7. SCIENCE AND TECHNOLOGY IN THE NEWS

Introduction:

Most citizens get their information about science and technology from the popular media—newspapers, television, and popular magazines—rather than the scientific press. In this lesson, students analyze the amount of coverage given to news about science and technology in various forms of news media. They examine how the medium affects the coverage given to such issues, and they suggest areas for improvement.

Objectives: Students will be able to:

1. Identify science and technology issues in the news media.

2. Gather data on coverage of science and technology issues in the news media.

3. Compare and contrast coverage in various media.

4. Suggest improvements in news coverage of science and technology issues.

5. Value the role of the press in providing the public with information about issues related to science and technology.

Subject/Grade Level: Any secondary science or social studies course

Time Required: 2 class periods

Materials and Preparation: Check the newspaper and television news programs for several nights prior to using the lesson to compile a list of scientific and technological developments in the news. Make copies of Handout 7-1 for all students.

Procedure:

1. Make a chalkboard list of the scientific and technological developments that have been in the news recently. Poll the students to find out how many are aware of why these developments have made "news" in the past few days.

2. Discuss with students where they get most of their information about science and technology. Do they learn more from newspapers, television, and newsmagazines, or from specialized science publications? Discuss the importance of the popular media in shaping public perceptions of science and technology.

Developed by Laurel R. Singleton, SSEC.

3. Tell students they will be analyzing how the news media cover scientific and technological developments. Divide the class into three groups and distribute copies of Handout 7-1. Assign one group to conduct a content analysis of daily newspapers, the second group to analyze television news programs, and the third group to analyze weekly newsmagazines. Students should use the analysis instrument for a specific amount of time; one or two weeks is recommended.

4. After the analyses have been completed, ask the students to compare the emphasis the different news media give to science and technology and to speculate why time/space was allocated as it was. Students should also attempt to determine how the technology involved in each medium affects the way news is covered (for example, television focuses on stories that have a strong visual component, has great immediacy, can bring a story to the audience as soon as it happens, etc.). The following questions may be used to summarize the discussion:

- Do the news media take a positive, negative, or balanced view of developments in science and technology?
- How do the news media influence the way the public thinks about science and technology?
- Do the news media show the effects of science and technology on society?
- How would you improve coverage of issues related to science and technology by newspapers? television? newsmagazines?

5. Have students individually or with other members of their groups write letters to the editor of one medium suggesting improvements in coverage of science and technology issues or complimenting the editor on coverage given these issues. The letters should address such concerns as balance and depth of coverage.

Extension/Enrichment:

Let students plan their own "newscasts" on science and technology issues. Their programs should address the problems the identified in doing their analyses.

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NEWS MEDIA ANALYSIS FORM

Use this form to record the amount of attention devoted to issues related to science and technology by ______________________________
____ during the period ___________________________.

Publication or broadcast date	% of time/space devoted to science/technology	Science/technology issues covered	Was coverage positive, negative, or balanced?	Was the effect of science and technology on society covered?

8. WILL THE REAL SCIENTIST PLEASE STAND UP!

Introduction:

This activity focuses on student misconceptions about who scientists are and what they do. Scientists are middle-aged white males who wear lab coats and glasses. Their peculiar facial features are indicative of their generally deranged behavior. They work indoors, alone, perhaps underground, surrounded by smoking test tubes and other pieces of technology. An air of secrecy and danger surrounds their work. This is the stereotype of scientists that was compiled from recent studies of student perceptions in grades 3-12.

Larry Flick began doing this activity in conjunction with a Scientist in Residence program during the 1987-88 school year. The program involved 43 fifth- and sixth-graders. Analysis of their drawings showed that male scientists dominated the girls' drawings as much as they did the boys'. In the sixth grade, only 7 percent of the figures were clearly female. Nearly all the students (96 percent) drew a scientist working alone, most of them near smoking test tubes and beakers.

Through subsequent interaction with scientists, students made some startling discoveries about scientists. For example, many students had never considered that scientists could have families or a sense of humor—or that they or their classmates could understand what scientists were saying!

This activity may provide either a constructive break in the normal science curriculum, serve as an introduction to a unit on science careers, or be implemented as part of a social studies unit on stereotypes. It is an activity that most teachers can do easily. You'll discover that scientists, both in universities and industry, share our concern about students' perceptions of scientists, and that they are eager to help.

Objectives: Students will be able to:

1. Describe the characteristics that people tend to attribute to scientists.

2. Identify which of these beliefs about scientists and their work are misconceptions and be able to explain why those ideas were misconceptions.

3. Recognize that scientists are human beings, sharing characteristics with nonscientists.

Subject/Grade Level: Any secondary science or social studies class; especially appropriate for middle school

Time Required: 1 class period plus follow-up class visits by working scientists.

Adapted from Larry Flick, "Will the Real Scientist Please Stand Up!" Reprinted with permission from NSTA Publications, November/December 1989, *Science Scope,* National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201-3000.

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Materials and Preparation: You will need drawing materials, copies of Handout 8-1 for all students, and a supply of magazines and newspapers that can be cut. You will also need to make arrangements for one or more scientists to visit the class. Try to be sure that female and minority scientists are included and that a variety of scientific fields are represented. The scientists should be asked to briefly describe their work, especially its group and public aspects, and lead activities related to their work. For example, a biologist might lead students through the process of viewing plant cells under a microscope; a psychologist could conduct memory-enhancing activities.

Procedures:

1. Ask students to draw a scientist at work. You may wish to let them choose other modes of expression, such as writing a poem, story, or song. Using a mix of representations will likely reveal more dimensions of the stereotype. When explaining the assignment, choose your words carefully to avoid communicating your own stereotypes.

2. Allow students enough time to incorporate the desired amount of detail in their work. Creative effort cannot be rushed. Some students will want to spend 30 minutes on the project, others will be done in five. A happy medium might be 15 minutes.

3. Divide the class into small groups, in which individual students will present their drawings and defend the relationship between the drawings and their perceptions of real scientists. Depending upon interest and available time, this step may be worth considerable attention, but it requires at least another 15 minutes.

4. Give students a data sheet (Handout 8-1). These categories were gleaned from studies of student perceptions, but others may be added. Ask students to gather data from all of the projects and draw conclusions from this data. What is the class stereotype?

5. Over an extended period, conduct class visits by the scientists. After each visit, you may want to allow time for discussion of how the particular scientist who visited that day changed students' perceptions of scientists. Did the scientist fit the class stereotype?

6. After all the scheduled scientists have visited the class, conduct a discussion of what the visits revealed about scientists and their work.

7. Ask students to look for pictures of scientists in newspapers or magazines. Do the photos reflect what they have learned about scientists through this activity? Why or why not?

The photos gathered could be combined into a collage titled "Will the Real Scientist Please Stand Up?" Photos that reflect stereotypes could be separated from those showing scientists as human beings engaged in a group and public enterprise.

Extension/Enrichment:

Students could interview other scientists to further elaborate on what they have learned and to develop interviewing skills.

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Students could also conduct this activity with their parents, bringing parents' drawings back to class for analysis. How are the perceptions of adults who are not scientists similar to or different from stereotypes about scientists that students held?

Resources:

Chambers, D.W., "Stereotypic Images of the Scientist: The Draw-A-Scientist Test," *Science Education* 67, no. 2 (1983), pp. 255- 265.

Newton, David E., *Science Ethics* (New York: Watts, 1987).

Age-appropriate biographies of scientists could be assigned for follow-up reading.

Useful guides for linking scientists and students are available from the North Carolina Museum of Life and Science (see **Resources** section of book). Titles include *Sharing Science with Children: A Survival Guide for Scientists and Engineers* and *Sharing Science: Linking Students with Scientists and Engineers, A Survival Guide for Teachers.*

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SAMPLE DATA TABLE

Elements in the Image of a Scientist	My Own	All Girls	All Boys
1. Clothing			
2. Race			
3. Facial Features			
4. Instruments			
5. Symbols			
6. Technology			
7. Captions			
8. Location			
9. Gender			

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9. THE TECHNOLOGY TREE

Introduction:

Arthur C. Clarke's famous statement, that any sufficiently advanced technology is indistinguishable from magic, presents us with a double-edged sword (or perhaps a double-sided floppy). It evokes the wonder of new controls over natural processes. It also evokes the specter of people so awed by technology that they willingly suspend their disbelief in magic. If people assume that they cannot understand technology, they abrogate their ability to make decisions about it, to control it.

This lesson is designed to help explore the familiar, inescapable connections that every technology, regardless how exotic, possesses. Making connections visible helps demystify the complex, while also illuminating the necessity for reasoned analysis and critical decision making.

Objectives: Students will be able to:

1. Suggest technological systems and social systems affected by development of particular technologies.

2. List changes resulting from particular technologies.

3. Use a graphic representation to show interconnections among a technology, society, and social change.

4. Recognize the value of understanding these connections in thinking about new technologies.

Subject/Grade Level: Any social studies or science course; especially appropriate for U.S. history/grade 11

Time Required: 1-2 class periods

Materials and Preparation: Make an overhead of the sample technology tree, or copy it onto the chalkboard. Review the example so you can discuss it with students. Prepare copies of Handout 9-1 for the class.

Procedures:

1. Open the discussion with the statements from Victor Ferkiss provided at the top of Handout 9-1. These may be read, written on the board, or made into an overhead. Allow time for students to absorb the statements, then begin to question them for understanding. Students should be able to supply examples to illustrate their agreement or disagreement with any/all of the statements.

Developed by Robert D. LaRue, Jr., Boulder Valley (Colorado) Public Schools.

2. Display the sample technology tree. Explain that it provides a graphic representation of the interconnections of a technology (the automobile), society, and social change. Discuss the example with the class.

3. Distribute Handout 9-1. Go over the directions with students and have them begin work. Textbooks, newspapers, or weekly newsmagazines may help provide ideas. Some classes may benefit by working in groups. If class discussion has been animated, the handout can easily be assigned as homework.

4. Debrief by having selected students present their work. In the debriefing, consider these questions:

- How would we categorize the technologies selected by the students?
- How many revolve around information technologies?
- What evidence is there that shows this is an area of increasing concern in our society?
- How can seeing connections help us understand new technologies?
- How can examining the connections between science, technology, and society today help us in the future?

5. As an alternative debriefing strategy if the class worked in groups, collect a chart from each group. Then ask each group to do a second chart based on the technology selected by another group. Compare the charts drawn by the two groups, having students discuss the similarities and differences.

Extension/Enrichment:

Students may want to explore the technological and social systems surrounding a newly emerging technology (e.g., super conductivity). Their predictions of social changes resulting from the use of that technology could be presented as skits, video plays, or posters.

Resources:

Basalla, George, *The Evolution of Technology* (New York: Cambridge University Press, 1988).

Burke, James, *Connections* (Boston, MA: Little, Brown, 1978).

Ferkiss, Victor, "Technology and the Future: Ethical Problems of the Decades Ahead," in *Futures Research Quarterly*, Volume 2, Number 4 (Winter 1986), pp. 17-30.

Postman, Neil, *Technopoly: The Surrender of Culture to Technology* (New York: Vintage Books, 1993).

Stem Technology	**Branch** Technological System	**Branch** Social System	**Fruit** Changes Resulting From the Technology
	Road Engineering	Sales People	Increased mobility and speed
	metal/alloy production	Driver Licensing	Drunk Driving Deaths
	Plastics	Advertising	Family Conflict over car use
	Petroleum	Parking Spaces	Live farther from work
Automobile	Repair Networks	Insurance Systems	Easy movement of goods
	Rubber Production	Road Route Selection Process	Travel farther for vacations
	Paint Technologies	Pollution Effects/Control	Hectic pace of life
	Glass	Safety	Mass Transportion in Poor Shape.
	Electronics	Delivery Networks	Health risks higher due to pollution
	Textiles	Financing Systems	Greater privacy
	Radio Engineering	Physical Communications	High employment while the industry grew.

Handout 9-1

TECHNOLOGY TREE

> *No technology exists in isolation.*
> *Individual technologies are part of technological systems.*
> *Technological systems exist in social contexts.*
> *Technological systems modify the societies in which they exist.*
> *Victor Ferkiss*

Fill in the first blank on the left with an existing technology. In the column headed "Technological System," fill in branch technologies that are intertwined with the stem technology. "Social Systems" are people-oriented systems that are interwoven with the stem and branch technologies. Finally, list at least ten changes in society that resulted from the development of the stem technology.

Stem Technology	**Branch** Technological System	**Branch** Social System	**Fruit** Changes Resulting From the Technology

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10. TEN INVENTIONS THAT CHANGED OUR LIVES

Introduction:

This lesson acts as a discussion starter to introduce students to science, technology, and society issues. The interconnections of these three aspects of culture are explored through a brief reading, a categorizing exercise, and discussion. Throughout the exercise, students should be encouraged to examine their opinions for deeper insights.

Objectives: Students will be able to:

1. Explain the impact of ten innovations on society.
2. Recognize the relationships among these innovations.
3. Give examples of society's role in shaping technology.
4. Interview adults to gather information.
5. Value diverse opinions about the importance of particular technologies.

Subject/Grade Level: Any social studies or science course/grades 9-12

Time Required: 2-3 class periods

Materials and Preparation: Prepare copies of Handout 10-1 for all students. The best preparation for this exercise is for teachers to work through it themselves. Teachers should note areas where they can provide extra, analogous examples to illustrate the interconnections.

Procedures:

1. Distribute Handout 10-1 and allow 25-30 minutes for reading and work. (This assignment could be done in small groups.)

2. Begin the debriefing. Since this is primarily a discussion starter exercise to sensitize students to STS topics, student thought and opinion are of primary importance. The "correct answers" are those answers that demonstrate logic, perception, and the persuasive use of evidence.

3. The categorizing exercise (question 1) will probably be frustrating for students because of the difficulty of assigning some items to only one category. Force them to make a choice even though the categories are too rigid and exclusionary. Redirect student opinions/objections back to other members of the class for analysis.

Developed by Robert D. LaRue, Jr., Boulder Valley (Colorado) Public Schools.

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4. Complete the debriefing through Question 6. Write the following homework assignment on the board:

> Write a paragraph containing at least five sentences. The paragraph should explain how society directs changes in science and technology. To better understand how society can have that effect on science and technology, you will need to interview your parents or several other adults. In your paragraph use one of the examples they suggest to illustrate that relationship. You must include one quotation from an interview in your paragraph. This assignment is due: ___________.

5. On the due date, collect the homework. Allow 15 minutes for a discussion of the homework topic and the input students obtained from their parents. Discuss the examples students used in their papers.

Extension/Enrichment:

Have students work in small groups to brainstorm a list of how "today's problems reflect yesterday's successes." What kinds of problems could be created by today's technological successes?

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Handout 10-1

THE CONSUMER HIT PARADE

In the October 6, 1987, issue of *Newsweek*, Robert J. Samuelson described the ten products or services that he believed had changed post-war American society most profoundly, resulting in a "society of greater individual choice and mobility without many of history's wants and discomforts."

Samuelson's list included the following ten items:

- Television: "TV has surely changed politics; it brought the Vietnam War into living rooms. It's also expanded national culture..."
- Jet Travel: "It has shrunk the country."
- The Pill: "Along with working women and better appliances—subverted old sex roles."
- Air Conditioning: "It made the sun belt possible."
- Automatic washers and dryers: "They revolutionized housework."
- Antibiotics: "Drastically reduced the threat to life of commonplace injuries and infections."
- Health Insurance: "It made health care an entitlement."
- Long Distance: "It too has shrunk America."
- Social Security and Pensions: They made retirement "an expected part of life."
- Interstate Highways: "They've shaped suburbia by attracting offices, malls, and industrial parks, determining where we live, work, and shop."

Samuelson's list did not include computers. He described computers as one of the products "that mainly serve business" and therefore "don't count."

We often forget just how much society has changed. The consumer culture's emphasis on the "new" tends to keep us from focusing on the impact of change.

Skim over the questions below. Then reread "The Consumer Hit Parade." Answer the questions and be prepared to explain the reasoning behind your answers.

1. Place each of Samuelson's "Consumer Hits" into one of these categories:

Science	Technology	Society

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2. Explain why you agree or disagree with Samuelson's decision to omit computers from the list.

3. What items missing from Samuelson's list do you feel should be included?

4. Which items do you think he should have omitted?

5. For each "Consumer Hit," identify one scientific discovery that laid the groundwork for the development of that item.

    1)

    2)

    3)

    4)

    5)

    6)

    7)

    8)

    9)

    10)

6. Pick one of the items and list one positive and one negative effect that item has had on society. Be prepared to explain your examples.

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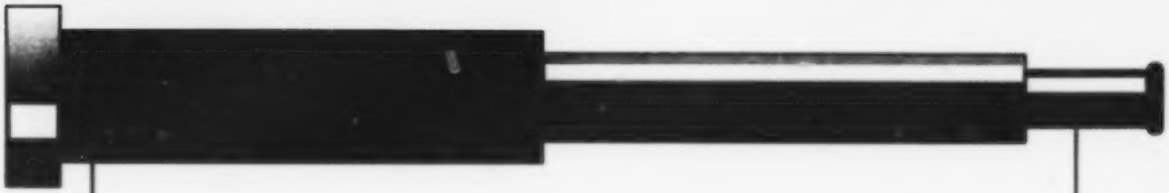

III. STS ACTIVITIES FOR SCIENCE CLASSES

11. SOIL DETERIORATION

Introduction:

Soil depletion is severe in many areas of our country. Whether natural or caused by humans, soil deterioration reduces soil to a nonproductive state. The end result is reduction in the amount of usable land. The "Dust Bowl" of the 1930s is a good example of soil depletion that led to widespread tragedy. Many local examples, although not as severe, still are causing great alarm. Often controversy arises over the sources of the problem, as well as possible solutions.

Through a field experience, students observe two areas of land—one that is productive and one that is deteriorated or eroded. This investigation is extended in a case study in which students must decide on a solution to a soil deterioration problem.

Objectives: Students will be able to:

1. Explain the difference between productive and nonproductive soil.
2. List some ways that humans cause soil deterioration.
3. Gather data on the productivity of two plots of soil.
4. Make inferences based on the data gathered.
5. Analyze policy options and recommend one policy.

Subject/Grade Level: Earth science/grade 8; general science/grade 9; environmental studies/grades 9-10; biology/grade 10; world geography/grades 7, 10

Time Required: 3-4 class periods

Materials and Preparation: Select two field sites. One should have productive soils with good plant growth. The other should be poor, depleted, or eroded soil. Once you have selected the sites, you will need to make arrangements for students to be transported to them. In addition, you will need copies of Handouts 11-1 and 11-2 for all students.

Procedures:

1. Begin the lesson by describing briefly to the class the conditions in the Dust Bowl in the 1930s. Stress the economic and social costs of the lost of soil, as well as the human and natural contributions to the problem.

Developed by Janice V. Pearson, Northglenn, Colorado.

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2. Take students to the first site. Ask them to make observations about the types of plants growing in the area, any wildlife apparent, any special ecological features of the area, and the topography of the area. Have students make notes on Handout 11-1 as they make their observations. They can complete their notes on site one while you are en route to site two. After similar observations at site two, have students complete the handout.

3. Conduct a class discussion of the following questions:

- Were there differences in the plants and animals living at the two sites?
- What do you think accounts for the differences you observed?
- Do these differences affect the productive capacity of the soil?
- What would the economic impacts be?

4. Tell students that erosion problems can occur in many different settings. As one example, they will be looking at erosion on coastlines. Distribute Handout 11-2 and allow time for students to read it. For older students, this could be assigned as homework; for younger students, in-class reading may be advisable.

5. Conduct a brief introductory discussion of the reading, focusing on how shoreline erosion occurs and its socioeconomic effects.

6. Divide the class into five groups. Each group will become a panel of experts on one of the five strategies for responding to erosion. Each group should identify the strengths and weaknesses of their strategy and decide whether to recommend that the strategy be incorporated into U.S. policy on coastal erosion.

7. When the groups have prepared their recommendations, select one person from each panel to serve on a congressional committee studying coastal erosion. Each panel should present a recommendation to the committee regarding their strategy. The committee should be allowed to ask questions of the panel of experts.

8. When all the groups have presented, ask the congressional committee to vote on a coastal erosion policy for the United States.

9. Conclude the activity by discussing the complexity of developing policy related to scientific issues.

Enrichment/Extension:

Encourage students to do more research on erosion and its impact on people. For example, some students might read *The Grapes of Wrath*, by John Steinbeck, while others learn more about the impacts of Hurricane Hugo on coastal erosion. Still others could investigate more thoroughly erosion issues in your own community.

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SITE NOTES

1. What kind of plants did you see growing at each site?

Site 1 ____________________

____

Site 2 ____________________

____

2. List the animals you observed at each site.

Site 1 ____________________

____

Site 2 ____________________

____

3. Were there any special ecological features in the area.

Site 1 ____________________

____

Site 2 ____________________

____

4. Describe the topography (landforms) in the area.

Site 1 ____________________

____

Site 2 ____________________

____

5. Evaluate the soil at each site.

Site 1 (Circle one) productive deteriorated

Site 2 (Circle one) productive deteriorated

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COASTAL EROSION

by Rutherford H. Platt, Timothy Beatley, and H. Crane Miller

In April 1888, the Brighton Beach Hotel on Coney Island, New York, was relocated 450 feet inland to save it from an eroding shoreline. The hotel's owner, the Brooklyn, Flatbush, and Coney Island Railroad, jacked up the building and hauled it inland in one piece using 6 locomotives, 112 flatcars, and 24 specially laid tracks. A century later, in April 1988, a committee of the National Research Council advised the National Park Service that the best way to save North Carolina's Cape Hatteras lighthouse from erosion would be to lift it up and gradually roll it along a temporary concrete slab to a new site a few hundred feet inland.

The concept of relocating a structure away from an eroding shoreline of one of the oceans or the Great Lakes has been widely advocated in the United States but is seldom achieved in practice. Instead, the prevailing responses to coastal erosion have been either to ignore it or to safeguard shorefront development with engineered, or "hard," shore protection projects, such as sea walls, revetments, groins and jetties, or breakwaters. Properly designed hard shore protection may insure high-value property investments for an indefinite period, but it is not usually cost-effective for less intensively developed areas. Hard shore protection is costly to install and maintain and may be rendered ineffective by a rise in the sea level or continued shoreline recession. Furthermore, hard shore projects can endanger the environmental and recreational values of a coast, for example, by contributing to the loss of beaches.

Physical Processes

The tidal shorelines of the United States, not including small embayments and islands, extend approximately 38,000 miles. The nation's coasts display great physical variation, including crystalline bedrock, eroding bluffs and cliffs, pocket beaches between headlands, strandplain beaches, barrier beaches, coral reefs and mangroves, and coastal wetlands. All of these shoreline types, except crystalline bedrock and certain coral formations, are potentially subject to erosion....

Erosion is both a natural and human-induced process. Natural erosion is the recession of beach or bluff shorelines in response to a "dynamic equilibrium" among several variables, including materials such as sand supply, silt, and flotsam; energy provided by wind, waves, currents, and tides; beach profile (width and slope); and relative sea level. Erosion is an episodic phenome-

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Excerpted from "The Folly at Folly Beach," *Environment* 33:9 (November 1991), pp. 6+. Reprinted with permission of the Helen Dwight Reed Educational Foundation. Published by Heldref Publications, 1319 Eighteenth Street, NW, Washington, DC 20036-1802. Copyright © 1991.

non that occurs in sudden pulses in response to storms, hurricanes, and periods of exceptionally high tides. Materials that are eroded from one shoreline may contribute to accretion on another shore or may be deposited on offshore bars, according to the influence of tides and currents.... natural shoreline change may be drastically affected by deliberate or inadvertent human intervention in coastal processes. Groins and jetties built perpendicular to the shore intercept shifting sand on the updrift side, but deny sand to the opposite, or downdrift, shoreline. Assateague Island National Seashore in Maryland has experienced pronounced landward recession because the Ocean City, Maryland, inlet jetties intercept sand moving in the southerly drift. Some municipalities have installed sand transfer facilities at inlet mouths to mitigate such downdrift sand deprivation. Also, protecting receding shorelines with sea walls and revetments may accelerate, rather than prevent, the disappearance of the beach front. Whether this phenomenon, characteristic of the New Jersey shoreline, is worsened by the protective structure or is simply the result of ongoing erosion is heavily debated among coastal engineers and geologists.

Socioeconomic Effects

Of course, accessible coasts attract seasonal and year-round populations. Much of the U.S. population now lives within a two-hour drive of a coast, and millions of inlanders travel much farther to vacation or attend conventions and meetings at oceanside or lakeside resorts. Demographic and economic pressures have thus transformed the sparsely developed shorelines of the 1940s and 1950s into "cities on the beach." In the process, conflicts have arisen among neighboring property owners, between adjacent political jurisdictions, between private and public claims to the shoreline, and between human activities and natural coastal processes, such as erosion.

The effects of erosion upon human settlements are substantial but difficult to quantify. Many private dwellings and commercial structures are at risk because of undermining along eroding tidal coasts. Septic systems, for instance, may be destroyed by erosion, thus making the dwellings they serve uninhabitable. Similarly, public infrastructure, including roads, sewers, water lines, parking lots, pavilions, toilets, and bath houses, may be damaged by erosion.

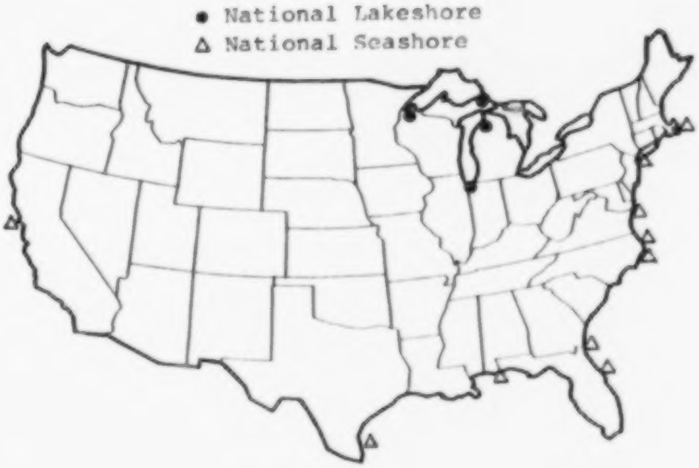
Erosion nibbles and sometimes devours valuable coastal real estate. At Chatham, on Cape Cod, Massachusetts, a new inlet was created on Nauset Beach, a barrier spit, during a 1987 winter storm. Within months, the inlet had widened to a mile. Ocean surf caused the previously sheltered mainland shoreline to recede by 76 feet during 1987, destroyed one home, and forced the relocation of others. Some homeowners have installed massive rock revetments to protect their property, which, in turn, has caused increased erosion in adjoining areas.

Erosion losses frequently occur during storms and are often classified as "flood losses" by the U.S. National Flood Insurance Program (NFIP). NFIP insures against flood-related erosion losses in eligible communities but lacks any mapping or land-use management requirements pertaining to erosion that is unrelated to flooding. In fact, erosion often serves as the advance wedge for flooding by magnifying the vulnerability of coastal structures to eventual loss. However, bluffs that have become undermined may simply collapse without warning or storm-induced flooding. This phenomenon was a serious threat to property owners on the shores of the Great Lakes, which experienced a period of high water levels in the mid-1980s....

National Policy

There is no single, coherent national policy on coastal erosion. Instead, the federal response to erosion has been ad hoc, sporadic, and sometimes inconsistent among competing objectives. Five strategies for responding to erosion, either explicitly or indirectly, have been utilized by the U.S. government under diverse congressional mandates: shoreline protection; direct federal regulation; public ownership for eroding shorelines; incentives for state planning; and insurance and mitigation of erosion losses. The first four of these strategies have proved to be of limited geographical or functional utility in expressing a national policy on coastal erosion. The fifth strategy is still evolving.

- The *protection* strategy has been largely applied to urban shorelines, and such projects proceed according to the whims of the congressional appropriation process or nonfederal funding. Hard shoreline protection has begun to fall out of favor because of its economic and environmental costs, and, particularly, the loss of recreation, habitat, and aesthetic values. North Carolina, for example, prohibits the use of hard shore protection in most circumstances. Replenishing beach sand, or "soft" shoreline protection, is more common at present. This method, which is often called beach nourishment, has been successfully applied at Miami Beach and many other locations in Florida where wave energy is low, the sand supply is accessible, and beaches are publicly owned and easy to reach. Convoys of dumptrucks full of sand are an annual rite of spring at Virginia Beach, Virginia. Massive, federally sponsored beach nourishment projects at major beach resorts, such as Ocean City, Maryland; Sandy Hook, New Jersey; and the south shore of Long Island, New York, have achieved marginal success, despite heavy sand losses during winter storms. Privately owned shorelines are generally ineligible for federal beach nourishment funding.
- Direct *federal regulation* has so far had little effect on the management of ocean shorelines. The U.S. Clean Water Act authorizes the Army Corps of Engineers to regular dredge and fill activities in U.S. water in accordance with environmental guidelines issued by the Environmental Protection Agency. This authority has been applied chiefly to estuarine and lakeshore wetlands, mudflats, and other aquatic habitats, but not to beaches, dunes, or uplands facing open water. The U.S. Rivers and Harbors Act regulates encroachments in "navigable waters" and does not apply to eroding shorelines.
- The *public ownership* strategy has been pursued at the federal level largely by the National Park Service and Fish and Wildlife Service, both agencies of the U.S. Department of the Interior. Under various acts of Congress, the park service has established 10 national seashores and 4 national lakeshores that preserve important segments of undeveloped coastline, including portions of Cape Cod, Massachusetts; Fire Island, New York; Assateague Island in Maryland and Virginia; Cape Hatteras and Cape Lookout,



North Carolina; Padre Island, Texas; Point Reyes, California; and the Indiana dunes. The Park Service also manages coastal property within national recreation areas and other parks, and its policy toward erosion is "to let nature have its way" wherever possible. At Cape Cod National Seashore, for instance, the park service is moving parking lots and other facilities away from the eroding bluff. The Fish and Wildlife Service manages several national wildlife refuges where erosion is occurring but does not threaten development.

Federal ownership of coastal shorelines is supplemented by state and local acquisitions and by nonprofit land-saving organizations, such as The Nature Conservancy. In 1981, public and quasi-public ownership accounted for slightly more than half of the total shoreline of Atlantic Ocean and Gulf of Mexico coastal barriers, perhaps an equivalent proportion of the Pacific Ocean coast, but a much smaller share of the erodible shores of the Great Lakes.

- The *planning* strategy, which is implemented through the U.S. Coastal Zone Management Act of 1972, supports 29 eligible state and territorial coastal management programs. To be approved for funding, all proposed lands must address public issues specified by the Office of Ocean and Coastal Resource Management. Although erosion is superficially included among these policy concerns, the act requires only that states establish a "planning process for assessing the effects of, and studying and evaluating ways to control, or lessen the impact of, shoreline erosion and to restore areas adversely affected by such erosion." State governments are not required to limit land development in erosion-prone areas, though several now do so.
- An *insurance and mitigation* strategy could address erosion hazards within the framework of NFIP under the auspices of the 1979 Federal Emergency Management Agency. NFIP has insured property against "flood-related erosion" since 1973. To date, the agency, which administers NFIP policies, has failed to map erosion zones or to specify management standards that could be applied by communities that contain such areas. To protect against flooding, NFIP requires that new or substantially rebuilt structures must be elevated above the estimated "100-year flood" elevation, which is the estimated height of coastal storm surge, including wave heights, that could occur in a 100-year period. In "coastal high-hazard areas" along open coasts, new construction must occur "landward of the reach of mean high tide" and may not cause "man-made alteration of sand dunes or mangrove stands,...which would increase potential flood damage." Because NFIP does not require new construction to be set back landward of the mean high-tide line, structures are commonly raised on stilts to meet NFIP elevation requirements and are built as close to the water as is physically possible. Thus, shorelines may eventually erode beneath such structures, leaving them stranded in the surf zone.

Over the past decade, the U.S. Congress has amended NFIP in two respects relevant to coastal erosion. The Coastal Barrier Resources Act of 1982 prohibited flood insurance and certain other federal benefits on specified undeveloped, nonpublic sections of coastal barriers along the Atlantic Ocean and Gulf of Mexico shorelines. Such areas, which are collectively designated as the Coastal Barrier Resources System, originally included about 656 miles of ocean front. The system was expanded by a congressional amendment in 1990. Coastal property within the system may still be developed regardless of erosion or other hazards, but flood insurance, shoreline stabilization, and other federal growth incentives will not be available.

In 1987, Congress addressed the problem of erosion directly, but cautiously, in the Upton-Jones Amendment. This amendment authorized NFIP to reimburse property owners for demolishing or relocating insured structures that are "subject to imminent collapse or subsidence as a result of erosion." By passing the amendment, Congress sought to encourage the removal of erosion-prone structures prior to their actual collapse to avoid higher NFIP costs and public safety hazards. Eligibility for Upton-Jones benefits is very restricted, however. As of 2 May 1991, only 228 claims had been approved nationwide, including 177 for demolition and 51 for relocation. The amendment has played a very minor role in the reconstruction of shoreline communities following Hurricane Hugo.

On 1 May 1991, the U.S. House of Representatives adopted the Flood Insurance, Mitigation, and Erosion Management Act. This bill would require the Federal Emergency Management Agency to incorporate erosion hazard data on NFIP maps sufficient to designate 10-, 30-, and 60-year erosion setback lines based on average annual erosion rates. Communities participating in NFIP would then be required to prohibit new construction seaward of the 30-year erosion setback line. Construction between the 30- and 60-year setback lines would be limited to movable residential buildings consisting of up to 4 units. Owners of existing insured structures situated seaward of the 10-year setback would have 2 years to take advantage of demolition or relocation benefits before losing full insurance coverage. No new flood insurance would be provided for any structure seaward of the 30-year setback line. If passed by the Senate and signed into law, the bill would effectuate an insurance and mitigation response to erosion hazards through NFIP.

Conclusion

To overcome the influence of political pressure on the management of erosion-hazard areas, public policy should follow several guidelines.

First, Congress should amend the National Flood Insurance Act to require that the Federal Insurance Administration obtain data on historical erosion rates for marine and Great Lakes shorelines where significant real estate investment is now or could be soon at risk. Some states, such as South Carolina, North Carolina, Florida, and Michigan, already have acquired the best available data, which also may be utilized for federal purposes.

Second, coastal communities that participate in NFIP (most do) should be required to establish erosion setbacks of 30 years for single family homes and 60 years for other structures, applicable in each case to new, rebuilt, or relocated structures. Existing state setbacks that meet or exceed these standards also should be incorporated.

Third, no new flood insurance coverage should be provided for new or existing structures that are located seaward of the 10-year setback. Owners of structures currently insured within that high-risk zone should be given two years to demolish or relocate their structures, with the benefit of subsidies. After two years, flood insurance coverage should be sizably reduced and premiums should be raised to reflect the increasing risk of undermining by erosion.

Fourth, Congress should declare a national policy favoring gradual retreat from eroding shorelines. Soft shoreline protection should be the preferred form of shoreline stabilization, provided that nonfederal interests fund at least two-thirds of the costs. Hard shoreline protection should be excluded from federal funding, except to maintain existing federal projects or to protect a critical public or private facility. Furthermore, Congress should commission an interagency effort to develop pilot communities that incorporate flood and erosion protection measures, including structural relocation and land-use planning.

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12. LAND USE

Introduction:

Decisions affecting the character and use of a particular area of land are made daily, often with very little information or consideration of the alternatives. Small groups of individuals, such as a city council or county commissioners, often make such decisions. Yet land use issues are seldom clear-cut; they are complex and often involve trade-offs. For this reason, open hearings have been established to enable local or state leaders to determine what citizens' views on these matters are.

This lesson provides students an opportunity to look at a land-use issue. Through a role play, students determine how a land-use decision would affect each individual involved, look at pros and cons of the proposed use of the land, and decide what use would benefit the majority of citizens involved.

Objectives: Students will be able to:

1. List a variety of purposes for which land can be used.
2. Explain why land-use issues can be very controversial.
3. Analyze a land-use issue and determine the effects of various alternatives.
4. Synthesize information on a land-use issue and come to consensus on the best solution.
5. Appreciate analysis and consensus building as methods of decision-making.
6. Value individual citizen input in decisions that have a community impact.

Subject/Grade Level: Life science/grade 7; earth science/grade 8; general science/grade 9; environmental studies/grades 9-10; biology/grade 10; civics/grade 9

Time Required: 2-3 class periods

Materials and Preparation: Make copies of Handout 12-1 for all students. Make one set of the role cards. Prior to using the lesson, you may wish to review the roles and determine the group assignments accordingly. You may also wish to make an overhead of the questions in step 6 of the **Procedures**.

Procedures:

1. Open the lesson with a brief discussion of the need for individual citizens to participate in community decision-making, particularly on issues that could affect the economics of individuals and the community, as well as the environment. Continue by telling students that many issues

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Developed by Janice V. Pearson, Northglenn, Colorado.

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affect a community. One such issue that often causes a great deal of controversy is land use. People have different ideas about the best use for a piece of land. All of the people affected by how a piece of land will be used have a right to help determine the best use for the land.

2. Give each student a copy of Handout 12-1. Have each student read the case study or assign one or more volunteers to read the case study aloud.

3. Ask students to brainstorm a list of ways in which Mrs. Howard's pasture might be used. Write this list on the chalkboard. Don't eliminate any suggestions—all are valuable.

4. Next, see if there are ways items on this list can be combined. For example, suggested ways of using the land might be categorized as recreational, industrial, commercial, residential, etc.

5. Divide the class into seven groups. Tell each group to select one person to act as group spokesperson. Give each group a role card. Have groups review their roles and discuss the use of the land that each is proposing.

6. To help groups evaluate their proposals, ask them to consider the following questions. These questions will stimulate thinking about the proposal and will suggest points that can be presented to the city council for consideration. You may want to put the questions on an overhead.

- What is the science or technology involved with your proposal?
- What is the social issue involved with your proposal?
- Would this proposal be controversial? If yes, in what way?
- How would this proposal benefit the residents of Angel Harbor?
- Will this proposal create new jobs or leave people without jobs?
- Describe the impact this proposal would have on the community of Angel Harbor.
- Would this be a positive or negative impact?
- How would this proposal change the ecology of the area?

7. Allow groups time to prepare a presentation that the group spokesperson will make to the city council. This presentation should be designed to convince the city council that a particular proposal is the best one for Angel Harbor.

8. Prior to the presentations of the proposals, select one student from each group to act as a city council member. Students who are not group spokespersons or city council members will represent the citizens of Angel Harbor and can ask questions of the spokespersons.

9. As the spokespersons present their proposals, the city council members should listen to the arguments and the questions raised by the citizens of Angel Harbor.

10. After all the spokespersons have reported and the citizens have asked any questions they have, summarize the input from the groups. You might make a chart on the chalkboard and list responses to the following questions:

- What is the science or technology involved with each proposal?
- What is the social issue involved with each proposal?
- Which of the proposed uses of the land would create the most controversy? Why?

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- Which of the proposed uses of the land would be most beneficial to the residents of Angel Harbor?
- Which of the proposed uses of the land would be least beneficial to the residents of Angel Harbor?
- Which of the proposed uses of the land would affect taxes?
- Which of the proposed uses of the land would affect people's lifestyles? How?
- Which of the proposed uses of the land would create new jobs?
- Which of the proposed uses of the land would leave people without jobs?
- Is this piece of land suited to each proposed use? In what way?
- How will each proposed use affect the ecology of this area?
- What are the pros and cons of each proposal?

11. After these questions have been discussed, ask the members of the city council to deliberate for a few minutes and determine the one proposal that seems to be best for the residents of Angel Harbor. After deliberation, have the city council members announce their decision, giving reasons for their selection.

12. Discuss the decision with the class. Take a poll or use a show of hands to determine how many students agree with the decision of the city council. Ask students if they think this method of decision-making is fair. Would this be a good way for cities to make important decisions, such as land-use decisions?

13. Conclude by asking students what they learned from participating in this kind of activity. Also ask students to comment on why it is important for citizens to become involved in community decision-making.

Extension/Enrichment:

Have students explore their neighborhoods to find proposed zoning changes or requests for variance. Good places to look include vacant lots or large parcels of empty land, on buildings in older neighborhoods that are undergoing changes, or in areas where new construction is starting. Tell students to examine the signs for the following information:

- What is being requested—a zoning change or a variance.
- When the hearing will be held.
- What city or county agency is holding the hearing.

Students might contact someone living next to or near this land to find out his or her opinion about the proposed change and then report their findings to the class.

Plan a field trip to a meeting of a city or county planning commission so students can see firsthand the work that is done in determining uses for community lands.

MRS. HOWARD'S PASTURE

Angel Harbor is a bustling community of 48,000 people. Its primary industries are fishing, lumbering, and the manufacture of fishing equipment and furniture. Angel Harbor is located on the ocean. The Angel River, a small river fed by mountain springs, flows through the center of the city on its way to the ocean. The river provides water for farms outside of the city. Angel Harbor has numerous parks and recreation facilities along the river.

Eleanor Howard has lived in Angel Harbor all her life. Her big house sits along the river on the edge of town. She has about 200 acres of land around her home, which she uses as pasture for her herd of horses. Recently, Mrs. Howard deeded 30 acres of riverfront pasture land to the community, with the requirement that the city council determine a use for the land that would be most beneficial for the majority of the community.

The city council encouraged the entire community to present proposals for the use of the land. The council received seven proposals. The council must now decide which proposal is the best one for the community. A town meeting has been scheduled. At this meeting, the seven proposals will be discussed by citizens and the city council.

Directions:

1. Your group will represent one of the people presenting a proposal to the council. First read your role. Then develop a presentation that will convince the city council and the community that your plan is the best one.

2. Select one member of the group to be the spokesperson. He or she will argue your group's position at the town meeting.

3. The teacher will pick one person from each group to serve as a member of the city council. The rest of the group members will represent citizens of Angel Harbor and should listen to the arguments made by each of the seven spokespersons and ask questions. The questions should help the city council decide which proposal really is the best one for the people of Angel Harbor.

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ROLE CARDS

1. Peter Blair

I represent a group of individuals who would like to build an amusement park for Angel Harbor. We feel this type of entertainment would be beneficial to the city. It would provide a place for adults and children to enjoy themselves, particularly on the weekends and evenings during the summer months. An amusement park would also be a tourist attraction. The people who would come to enjoy the amusement park would also eat at local restaurants and buy gasoline and other products from local merchants, thus adding to our economy.

The amusement park would add approximately 20 jobs for local residents. Because the land in question is on the edge of Angel Harbor, the music and lights of the amusement park would not be a nuisance to the residents of the community. There would be no cost to the city. The investment group would pay for the entire development.

2. Fay English

The land donated to the city by Mrs. Howard is priceless. This land is home to many kinds of animals. White-tail deer are frequently seen drinking from the river in the early morning and late evening. Several varieties of ducks and geese spend the winter in this area. We have beaver and muskrat on the river banks. And the river is teeming with all kinds of fish.

It would be in the best interest of the citizens of Angel Harbor to maintain this land in its natural state, a wildlife preserve. We could build a parking facility near the highway and trails to and from the river. This would allow people to study the wildlife in this area while safeguarding the habitat for these local species. The cost to the city would be approximately $5,000 for the parking area and $2,500 for the trail and trail markers. I am certain that many of the service organizations in our city would see this as a worthwhile community project and would donate both time and money to the development of a wildlife preserve.

3. Bob Evans

We need moderate-priced housing in Angel Harbor. High-paid professionals can choose from many new and older homes, but many workers and retired persons cannot spend $80,000 to $100,000 for a home. My company, Evans Brothers Homes, would like to purchase the land donated to Angel Harbor by Mrs. Howard. We would offer fair market price for the land. In turn, we would build single-family condominiums on the land. We would sell each unit for $58,000 to $67,000, depending on the number of bedrooms and other options desired by the buyer.

We anticipate that 60 condos could be built on this land. This development would be attractive and would add to the tax base for our community and school system.

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4. Evelyn Cooper

This city needs a good family restaurant. We have fast-food restaurants and gourmet restaurants. But we need a restaurant that caters to families with big appetites and not too much money. What better place to build a restaurant than in a pleasant country setting?

I would like to purchase this land from the city. On the land I would build my restaurant. It would be built close to the river so that access on and off the main road would not cause congestion. My new restaurant would create jobs for 15 Angel Harbor residents.

5. Bill Dunn

Angel Harbor's citizens take pride in their community. We are careful to keep our city clean and attractive. However, our fair city will soon experience a garbage disposal problem if alternatives are not found. As city sanitation manager, I have studied Angel Harbor's solid waste treatment methods. If Angel Harbor continues to dispose of its solid waste at the municipal landfill, the landfill will be completely filled in seven years.

I am proposing a recycling center for such materials as paper, glass, aluminum cans, and other metal products. This center would not need the entire 30 acres of land and could be built near the main road. The initial cost to the city would be $60,000, but it would extend the life of the landfill by 25 years and would earn $25,000 each year. The City Council would need to make recycling mandatory to make my plan work.

6. Calvin Bristow

I am the girl's and boy's basketball and baseball coach at Angel Harbor Junior High School. I believe the children and adults of Angel Harbor need a better place for their recreational sports. The facilities available at the schools are adequate for school sports, but many adult and student softball and soccer leagues need fields on which to play and practice. I propose that the city build two baseball fields, four softball fields, and four soccer fields, along with stands for spectators, a concession area, dressing facilities for males and females, and a parking area to serve the entire complex. The complex would cost $30,000 to build. Through donations and community projects to raise funds, however, the city would not have to spend more than $15,000.

7. Maureen Vincent

As a safety engineer hired by the city of Angel Harbor, I recommend that the Howard land be used to build a new fire station. This city is experiencing a great deal of growth, particularly to the north of the city, toward Mrs. Howard's land. Right now, the homes on the north end of town depend on the Russell Street Station eight miles away. This may not seem like a great distance, but when your home is burning, seconds count.

I encourage the city council to annex this land and use it to build a new fire station. The cost of $1.3 million dollars would need to be raised through a tax increase.

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13. ENERGY, ATMOSPHERE, AND CLIMATE CHANGE

Introduction:

On many days, visitors to the Grand Canyon can barely see the other side because of the haze from a coal-burning power plant. According to the *Wall Street Journal*, in Mexico City, where the air was unsafe to breathe more than 300 days in 1990, children now use gray paint for the sky in their city landscapes.

Given the seriousness of changes in the atmosphere, it is important to realize how our daily human activities, such as energy use, are adding pollutants to the atmosphere. Because pollutants collecting in the atmosphere trap heat, many experts predict that, by the 2030, when today's students will be the world's decisionmakers, average global temperatures will have increased by seven degrees Fahrenheit.

This lesson begins by looking at energy use in industrialized and developed countries and the relationship between energy use and air pollution. The lesson identifies reasons for concern about air pollution, global warming, and ozone depletion. Finally, strategies for dealing with changes in the atmosphere are examined.

Objectives: Students will be able to:

1. Identify and explain the major air pollutants and their sources.

2. Compare and contrast energy use in industrialized and developing countries.

3. Describe the apparent relationship between energy consumption patterns and air pollution patterns in industrialized and developing nations.

4. Identify the major "greenhouse gases" and their sources.

5. Explain why there is concern about air pollution, global warming, and ozone depletion.

6. Identify strategies for dealing with air pollution, potential global warming, and ozone depletion.

Subject/Grade Level: Earth science/grade 8; physical science/grade 9; environmental studies/grades 9-10; world geography/grades 7, 10; civics/grade 9, current events/grades 7-10

Time Required: 2-3 class periods

Materials and Preparation: You will need copies of Handouts 13-1 through 13-3 for all students; you will also need Transparencies 13-1 through 13-4 and an overhead projector.

World Resources Institute, *Teacher's Guide to World Resources: Energy, Atmosphere, and Climate*, Washington, DC, 1994.

Procedures:

1. The first part of the lesson focuses on energy use. Distribute copies of 13-1. The graph shows the world's countries grouped in two large categories (developing and industrialized). Three groups of developing countries are shown (Africa, Asia, and Latin America). Industrialized nations are in two categories: those belonging to the Organization for Economic Co-operation and Development (OECD) (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States) and non-OECD countries (Central Europe and the republics of the former Soviet Union).

Have students first answer questions on their own and then compare and defend their answers to questions 6-11 in small groups of three to five students. Finally, generate a class list of all reasonable answers from all groups. Suggested answers are as follows (the answers provided for 6-11 are not the only possible answers).

1. Asia.

2. OECD countries.

3. OECD countries.

4. OECD countries.

5. OECD countries.

6. Both groups of industrialized countries use only a small amount of traditional fuels. Both groups of industrialized countries use 25-30 petajoules of natural gas. Natural gas and coal are important sources of energy in both groups of industrialized countries. Primary electricity is the fourth most important source of energy for OECD and non-OECD countries.

7. OECD countries use about three times as much oil as non-OECD countries. OECD countries use more than three times as much primary electricity as non-OECD countries. OECD countries use more of every type of fossil fuel than non-OECD countries.

8. Traditional fuels are a significant source of energy for all developing countries. All three groups of countries use less than 10 petajoules of natural gas, primary electricity, and traditional fuels.

9. Energy use is higher in Asia than in Africa and Latin America. Coal is the most important fuel only in Asian countries. Asian countries use more oil than African or Latin American countries.

10. All countries use a mix of five different fuel types.

11. Energy use is higher in industrialized than developing countries. Traditional fuels are more important in developing countries than in industrialized ones. Industrialized countries depend more on oil and natural gas than do developing countries.

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2. Show Overhead Transparency Master 13-1. These graphs compare world commercial energy use with energy use in industrialized and developing countries over time (Figure a) and per capita consumption in industrialized and developing countries over time (Figure b).

Figure a shows that, worldwide, commercial energy use has been growing steadily. In the past 20 years, consumption has increased almost 50 percent. Also, total energy use in industrial countries is far greater than in developing ones. Each person in the industrialized world uses as much commercial energy as 10 people in the developing world. However, in most developing countries, modern commercial sources of energy are consumed mainly by the industrial and transport sectors in urban areas. In rural areas, people rely on traditional fuels such as firewood, animal and plant waste, and charcoal. These traditional fuels are not usually included in international statistics.

There are many more people in developing countries (about 80 percent of the world's population), who together use only a fraction of what people in industrialized countries consume. Figure b shows that the world average of consumption per person is 50 gigajoules. In industrialized countries, people use 3 to 3.3 times more, and this is still increasing.

The graph shows that consumption in industrial countries dropped when the oil embargo occurred (1974 and early 1980s), indicating that because of a combination of price increases and gasoline shortages, people in industrial countries began to conserve energy.

3. Distribute Handout 13-2 and allow time for students to read it. Use the handout to have students answer such questions as:

- What are the major air pollutants? What are their sources?
- How does air pollution affect human health? Have you experienced any problems related to air pollution?
- How does air pollution affect plants? Forests?
- Which of your own activities have the greatest effects on air pollution? How can you modify your activities to help improve air quality?
- What measures would you take to reduce acid rain? What human activities would you focus on? What pollutants would you try to reduce?
- Which air pollutants would you seek to reduce if you were interested in making the air healthier for us to breathe? How would you go about doing this?
- If you were the mayor of a large city, what steps would you take to improve your city's air quality? What activities in your city would you look at first?
- If you wanted to improve growing conditions for plants and forests, which aspects of air pollution would you look at first?

4. In a discussion of air pollution, it is interesting to look specifically at where in the world these problems are occurring. Using a map of the world, discuss with students the following trends in air pollution:

- In which regions of the world is acid precipitation a problem? (Regional acid rain is a problem in Europe and North America, and, increasingly, in China and Japan. In Europe, pollution damage to forests costs roughly $30 billion per year. Forest damage is evident in North America and is increasing in many parts of Central Europe and the Baltic republics.)

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- In which part of the United States and Canada is acid precipitation a problem? (Primarily in New England and certain areas of New York and North Carolina, Ontario, Quebec, and Alberta.)
- In which regions of the world is air pollution most severe? (In developing countries, overall emissions of pollutants are increasing due to rising energy demand, expanding vehicle population, and increasing use of inexpensive coal, especially in China. Many developing nations have seen increases in SO_2 or particulate levels, or both. Smog is likely to become more severe in developing countries. Levels of carbon monoxide are increasing in most of the developing world along with the increase in the number of vehicles and traffic congestion. The global vehicle population will double over the next 20-40 years to about 1 billion. Industrialized countries have made significant progress in reducing urban SO_2 and particulate levels. In Europe, North America, and Japan, SO_2 and NO_x emissions are projected to decline. Industrialized countries have reduced lead emissions, but lead contamination is a serious urban problem. Air pollution has caused serious health effects in many industrial areas of Central Europe and the former Soviet Union.)
- Which countries are most affected by air pollution from other countries? (Pollution from one country often causes damage in other countries: this is called transboundary pollution. European countries have been most affected by transboundary pollution and are the leaders in a series of international agreements to cut emissions.)

5. Show a transparency made from Overhead Transparency Master 13-2, which illustrates how gases in the atmosphere have a "greenhouse effect," trapping heat and keeping the earth warmer than it would be otherwise. Because concentrations of greenhouse gases are increasing rapidly, there is increasing concern about the possibility of climate change or global warming.

6. Next show a transparency made from Overhead Transparency Master 13-3, which shows how various human activities contribute to global warming. The largest category, "Energy Use," includes production and use of energy from fossil fuels—for example, electric power production and motor vehicle use. Industrial processes include cement production and manufacture of synthetic compounds such as chlorofluorocarbons (CFCs). Deforestation also releases large amounts of carbon dioxide because carbon stored in trees and plants is released into the atmosphere when forests are cleared and burned. Agricultural activities also release greenhouse gases: flooded rice paddies are a source of methane emitted by anaerobic bacteria, and nitrous oxide is produced by factorial action on chemical fertilizers.

Point out that human activities are not the only sources of greenhouse gases. Animals and plants exhale carbon dioxide. Swamps, marshes, tundra, and termites are sources of methane. There are also natural processes for absorbing these gases from the atmosphere. Carbon dioxide is absorbed in the oceans and in the soils and is taken in by plants during photosynthesis. Methane is decomposed by chemical processes in the atmosphere.

7. Distribute Handout 13-3, which contains additional information about the major greenhouse gases. Emphasize that the gases vary in their heat-absorbing potential. Adding a molecule of methane will trap 20-30 times as much heat as a molecule of carbon dioxide; adding a CFC molecule will trap 20,000 times as much heat as a carbon dioxide molecule. (However, new evidence shows that CFCs also have a cooling effect.) Point out that more and more greenhouse gases are being added to the atmosphere. The world's population is increasing. Energy use is rising, especially in developing countries (although these countries use far less energy than industrialized ones). Increasing use of fossil fuels has been part of the development process. Overhead Transparency Master 13-4 shows which countries are responsible for the largest percent of total emissions.

No one knows what the effect will be of adding such quantities of greenhouse gases to the atmosphere. One theory is that the earth's climate will grow warmer, unless other climatic mechanisms counteract the warming (e.g., the volcanic eruption of Mt. Penatubo).

Predictions of possible climate change are based in part on long-term studies of the concentrations of carbon dioxide in the atmosphere. Scientists have made computer models to try to predict whether global warming will take place, but there are a number of unknowns, such as how the dynamics of the ocean will be affected; how cloud behavior will affect the climate; and how living systems will respond to global warming and influence the climate.

While ozone is an air pollutant and a greenhouse gas in the lower atmosphere, in the upper atmosphere its effects are beneficial. It forms a protective shield against biologically harmful ultraviolet-B (UV-B) radiation. Stratospheric ozone is being depleted by atmospheric concentrations of CFCs and other ozone-destroying chemicals. Once in the upper atmosphere, a single CFC molecule can participate in the destruction of 100,000 ozone molecules. While it can take roughly 10 years before CFCs reach the stratosphere, CFCs have a life of 50 to 100 years. Because chlorine and bromine chemicals already released to the atmosphere will reach the stratosphere in coming years, ozone losses are expected to increase at least through the end of the century. Even if use of such chemicals is rapidly eliminated, full recovery of the ozone layer is not expected until about the year 2100.

8. Lead a brainstorming session on possible effects of global warming. Some possibilities identified by scientists are:

- *Health.* Tropical, mosquito-borne diseases such as malaria, dengue fever, and yellow fever might spread to a wider area.
- *Agriculture.* The growing season in areas of the northern hemisphere such as Finland, Japan, Iceland, and Canada, would be lengthened. However, yields of wheat, corn, and soybeans in the United States might decrease.
- *Forests.* Parasites from the tropics might extend their range and attack temperate forests. Some temperate tree species might become locally extinct.
- *Rangelands.* An ongoing decline in productivity from drought and erosion would intensify. Increased fires would be a problem.
- *Wildlife.* Many species would become extinct because their habitat would shift, shrink, or disappear.
- *Oceans.* Locations of currents and fisheries could change. Rising sea levels could flood coastal areas and threaten low-lying countries such as Bangladesh.
- *Islands.* Island nations fear they may disappear if the oceans rise. These states are urging action to stabilize the world's climate.

There is also concern about the potential effects of ozone loss because ultraviolet-B radiation is biologically harmful. Skin cancer rates are expected to increase—perhaps as many as 12 million more cases in the United States over the next 50 years. Other health effects will likely include an increase in cataracts and suppression of the immune system. Increasing UV-B radiation may affect marine life, disrupting some aquatic ecosystems. Many crops and plant species are likely to suffer cell damage and become less productive.

9. Tell students that they are going to consider some ways of dealing with air pollution, global warming, and ozone loss. Divide the class into four groups and assign each group one of the following areas: (1) motor vehicles, (2) industries and power plants, (3) agricultural practices, and

(4) everyday household activities. Each group is to create a poster or mural that shows the contribution their assigned category makes to the problems studied in this lesson and the group's suggestions for alleviating those problems. Allow ample time for the groups to look for additional information and to create their products. You may want to share some of the following information with groups that are struggling.

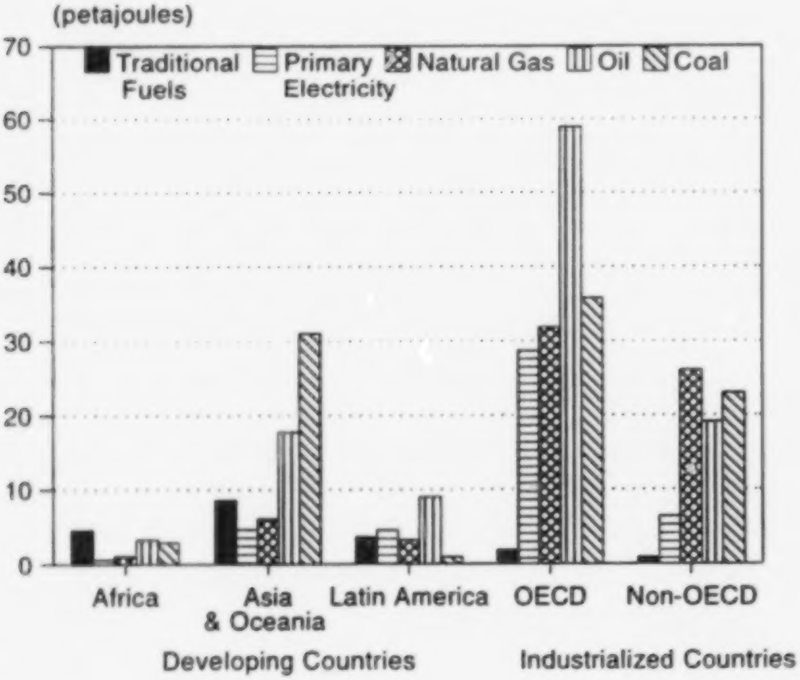
- *Motor vehicles.* Motor vehicles cause more air pollution than any other single human activity, yet the demand for motor vehicles is growing. A large increase in demand for new vehicles is expected in developing countries where motor vehicles are already a serious problem in many urban areas. Conservation strategies include developing energy efficient cars, decreasing automobile use by carpooling, using alternative transportation (public transportation, bicycling, walking). Other ways include developing vehicles that use alternative fuels such as electricity, using cleaner gasoline, and setting and enforcing emission standards.
- *Industries and power plants.* Techniques for decreasing pollution from these stationary sources include: closing the worst polluters; switching to low-sulfur fuel or natural gas; installing pollution-control devices such as scrubbers (such devices reduce air pollutants, but not the amount of CO_2 released); changing manufacturing processes to cut emissions (the auto industry has begun to use water-based paints that don't emit hydrocarbons); and setting and enforcing emissions standards.
- *Agricultural practices.* Practices that could be changed include developing new strains of rice that don't need flooding, enclosing manure piles and feedlots to capture methane.
- *Household activities.* About one-third of the energy consumed in the United States is used by individuals in their homes and cars. By using energy, students contribute to air pollution and "greenhouse gases." For example, watching five hours of television or using a 1500-watt hair dryer for an hour results in the emission of one pound of carbon. Using more energy-efficient appliances and reducing use of power appliances are strategies for reducing pollution through individual action.

Extension/Enrichment:

About 11,000 pounds of carbon or its heating equivalent are added to the atmosphere each year for each person in the United States. To help students identify ways in which their use of energy contributes to carbon emissions, have them keep a record of their energy use for one day. For example, they should record the appliances they use (radio or TV, toaster, hair dryer, etc.) and the amount of time the appliance is used, the length of time they use electric lights, how many miles they drive or are driven in a car (burning a single tank of gasoline produces 300-400 pounds of carbon dioxide, the most important greenhouse gas), etc. Once they have recorded their energy use, students should analyze it. In what ways could they save energy? Will any of these changes cost money? Will any of them save money?

Ask students to hypothesize whether local air quality is getting better or worse. Have students monitor air quality over a period of time. Usually, a report on air quality is available in the newspaper or through the telephone weather forecast number. Record each day's reading on a graph for one month. If figures are available, compare with the same month for the previous five years. Recording air quality statistics will help students identify particular pollutants such as sulfur dioxide. Have students research the major sources of local air pollution (auto emissions, power plants, factories). At what times of year does the worst air pollution occur? Join other students around the world monitoring air pollution, global warming, and ozone depletion and sharing their findings over telecommunications networks. For information and curriculum materials, contact TERC, 2067 Massachusetts Avenue, Cambridge, MA 02140. Phone (617) 547-0430.

TOTAL ENERGY USE BY FUEL TYPE, 1991



Source: United Nations Statistical Division (UNSTAT), "U.N. Energy Tape" on diskette (UNSTAT, New York, 1993). Note: Traditional Fuels include wood, charcoal, animal and vegetable waste. Primary Electricity includes hydro, geothermal, wind, and nuclear power generation.

To compare energy used by industrialized and developing countries, first answer these five questions:

1. Which group of countries uses the most traditional fuel?
2. Which group of countries uses the most primary electricity?
3. Which group of countries uses the most natural gas?
4. Which group of countries uses the most oil?
5. Which group of countries uses the most coal?

Now, look for similarities and differences in the energy used by these countries. State these in your own words, following the directions below.

6. Write one sentence that describes a similarity between OECD and non-OECD industrialized countries.

7. Write one sentence that describes a difference between OECD and non-OECD industrialized countries.

8. Write one sentence that describes how African, Asian, and Latin American countries are similar.

9. Write one sentence that describes a difference among African, Asian, and Latin American countries.

10. Write one sentence that describes a similarity between developing and industrialized countries.

11. Write one sentence that describes a difference between developing and industrialized countries.

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FACTS ABOUT AIR POLLUTION

Historically, air pollution has been a local problem. Small factories produced relatively small amounts of pollutants capable of causing local environmental damage. These pollutants rarely traveled far or caused widespread damage.

More recently, as industrialization and the use of automobiles has increased, air pollution has become a more regional and global problem. Even in the sparsely populated West, air pollution often makes it impossible to see across the Grand Canyon. In 1991, pollutants from burning oil wells in Kuwait spread across much of the Middle East and south central Asia.

Much of the world's urban population breathes unhealthy air at least some of the time. Polluted air is especially dangerous for sensitive groups such as children and the elderly. Air pollutants irritate the respiratory system and impair lung function. Air pollution causes environmental damage both to the urban environment by damaging buildings and to the natural environment. Polluted air damages and kills trees, crops, and other plants. Air pollution contributes to water pollution because many airborne contaminants eventually end up in rivers and lakes.

There are two types of pollutants: gases and particulates (solid and liquid material suspended in the air). The following table describes the main pollutants, their sources, and environmental and health effects.

Pollutant	Description	Impact	Sources
Sulfur Dioxide (SO_2)	Released when fossil fuels are burned.	Contributes to acid precipitation; damages buildings; causes respiratory problems.	Coal-burning power plants (65 percent), other combustion (18 percent, includes unvented heating and cooking sources), factories (13 percent), transportation (3 percent, other (1 percent).
Nitrogen Oxides (NO_x)	Released when fossil fuels are burned; react with volatile organic compounds in the presence of sunlight and heat to form smog.	Contribute to acid precipitation and smog; cause stinging eyes, coughing, increased asthma attacks, and greater susceptibility to infection. Also are toxic to plants.	Transportation (41 percent), coal-burning power plants (29 percent), other combustion (24 percent), factories (3 percent), other (3 percent).

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Pollutant	Description	Impact	Sources
Carbon Monoxide (CO)	Created by the incomplete combustion of carbon-containing fuels.	Contributes to ozone formation. When inhaled, can interfere with the body's ability to carry oxygen in the bloodstream.	Motor vehicle exhaust.
Volatile Organic Compounds (VOCs)	Combine with NO_x to form smog.	Eye irritation, respiratory irritation, and even cancer.	Transportation (41 percent), other industrial processes (19 percent), fuel combustion (13 percent), industrial surface coatings (10 percent), miscellaneous solvents (10 percent), oil storage (7 percent).
Particulates	Pieces of ash or smoke, soot, dust, and liquid droplets.	Contributes to respiratory disease.	Emitted during burning of fuels from dust, forest fires, conversion of SO_2 to sulfate.
Lead	Airborne lead particulates come primarily from auto exhaust. Can also be ingested through food and water.	Cumulative effects include circulatory, reproductive, nerve, and kidney damage. Children are especially susceptible.	Leaded gasoline, and lesser amounts from metal smelters, and manufacture of batteries.
Ozone	Formed when NO_x reacts with VOCs.	At ground level (as smog), threatens public health, injures trees, crops, other vegetation. In the stratosphere, acts as a filter, screening out harmful ultraviolet rays.	Formed in the air by reaction between nigrogen oxides and volatile organic compounds.

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FACTS ABOUT GLOBAL WARMING AND OZONE DEPLETION

The Earth's atmosphere, a thin blanket of gases, protects the planet from the harshest of the sun's ultraviolet radiation. The atmosphere, by trapping the Earth's warmth, keeps rivers and oceans from freezing. Carbon dioxide and water vapor are the most important gases in creating the insulating or "greenhouse effect" of the atmosphere.

The amount of carbon dioxide in the atmosphere has been increasing rapidly. Human activities are also releasing other "greenhouse" gases such as methane, ozone, and chlorofluorocarbons (CFCs), which intensify the heat-trapping properties of the atmosphere as a whole. CFCs also rise into the upper layer of the atmosphere, the stratosphere, where they destroy the protective layer of ozone, a gas that forms a shield against ultraviolet rays that can harm many forms of life.

About 1 million tons per year of CFCc have been released worldwide since the mid-1970s. In the lower atmosphere, CFCs contribute to global warming, but in the stratosphere, they trap ozone molecules, degrading the protective shield. In 1991, scientists concluded that decreased stratospheric ozone has a cooling effect on the lower atmosphere that may be large enough to actually offset part of the warming from greenhouse gases. If the warming effect of CFCs is offset by the newly discovered cooling effect, then phasing out CFC use will not decrease global warming. However, a phaseout will still protect the stratospheric ozone layer.

Concern is growing that atmospheric changes could bring on rapid, profound climatic changes.

Sources and Types of the Most Important Greenhouse Gases

Carbon Dioxide (CO_2): released by the burning of fossil fuel (oil, coal, and natural gas), flaring of natural gas, changes in land use (deforestation, burning and clearing land for agricultural purposes), and the manufacturing of cement. Accounts for one half of the warming potential caused by human activity.

Methane (CH_4): sources include landfills, wetlands and bogs, domestic livestock, coal mining, wet rice growing, natural gas pipeline leaks, biomass burning, and termites. Molecule for molecule, methane traps heat 20-30 times more efficiently than CO_2. Within 50 years, it could become the most significant greenhouse gas.

Chlorofluorocarbons (CFCs): industrial products developed 60 years ago. Used in refrigerators, automobile air conditioners, solvents, aerosol propellants, insulation. The most powerful of the greenhouse gases—in the atmosphere, one molecule of CFC has about 20,000 times the heat-trapping power of a molecule of carbon dioxide. In the upper atmosphere or stratosphere, CFCs degrade the ozone layer. One CFC molecule can trap as many as 100,000 ozone molecules. The thinning of the ozone layer may have a cooling effect on the lower atmosphere. It also allows penetration of more ultraviolet rays, which can cause skin cancers and cataracts in humans as well as damage plants.

Nitrous Oxide (N_2O): sources include burning of coal and wood, and soil microbes' digestion. Long-lasting gas that eventually reaches the stratosphere where it helps destroy the ozone layer.

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Ozone (O_3): an unstable form of oxygen. Produced by photochemical processes in the atmosphere when nitrogen oxides react with organic compounds. In the lower atmosphere, ozone is a greenhouse gas. (In the upper atmosphere, ozone absorbs much of the sun's damaging ultraviolet rays.)

Trends

Atmospheric concentrations of greenhouse gases are rising at unprecedented rates. Greenhouse gas emissions from developing countries are expected to increase rapidly.

Large-scale climate changes may occur unless other climatic systems counteract the warming effect of the greenhouse gases.

The eruption of the Mt. Pinatubo volcano in the Philippines in June 1991 sent a huge volume of ash and sulfur dioxide (SO_2) into the stratosphere that could temporarily change the earth's climate. In a single eruption, the volcano emitted almost 20 million tons of SO_2—nearly as much as the entire SO_2 emissions of the United States in one year. Sulfur dioxide creates a haze of sulfuric acid that reflects and scatters sunlight. Experts think this haze might lower average global temperatures by more than 0.3° F for three or four years, enough to mask global warming.

Total global energy use is projected to grow at an annual rate of 1.5-2 percent. Nonfossil energy sources are likely to become more important because of concern over global warming.

Cleaner, more efficient energy technologies can significantly reduce greenhouse gases from fossil fuels, especially over the next 20 years. However, total greenhouse gas emissions are likely to increase due to expanded energy use.

Demand for refrigeration (which has cooling systems that use CFCs) in developing countries is projected to increase greatly, especially in China and India.

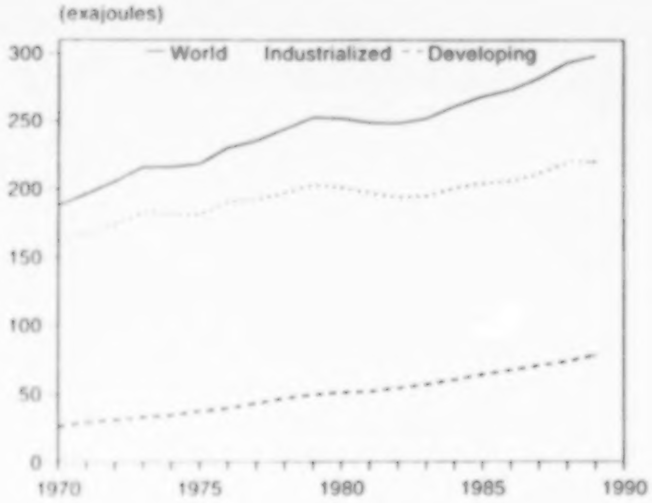
Ozone losses in the upper atmosphere are occurring at all latitudes in both hemispheres. The most striking example of ozone loss occurs over the South Pole during September and October. As ozone is lost, the amount of biologically harmful ultraviolet-B (UV-B) radiation will increase. Skin cancer rates are expected to increase. Other health effects will likely include an increase in cataracts and suppression of the immune system. Increased UV-B radiation may also harm plants.

The international community is taking steps to control and ultimately ban production of CFCs by the year 2000. By July 1991, about 70 nations had signed the Montreal Protocol on Substances That Deplete the Ozone Layer (1987). These nations represent over 90 percent of global CFC production and consumption.

Some developing countries are quickly phasing out CFC use. Others refuse to sign this treaty because they fear switching to ozone-friendly technology will be too expensive and hamper their development. A fund, financed by the largest CFC users, has been set up to compensate developing countries for the added costs of doing without CFCs.

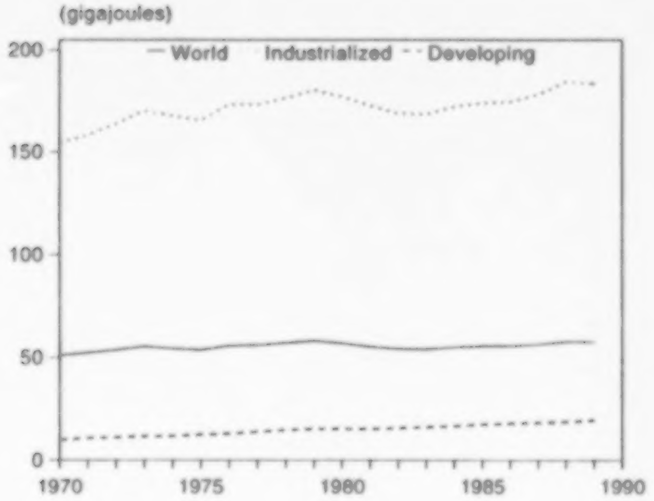
Trends in Global Energy Consumption

a. Commercial Energy Consumption



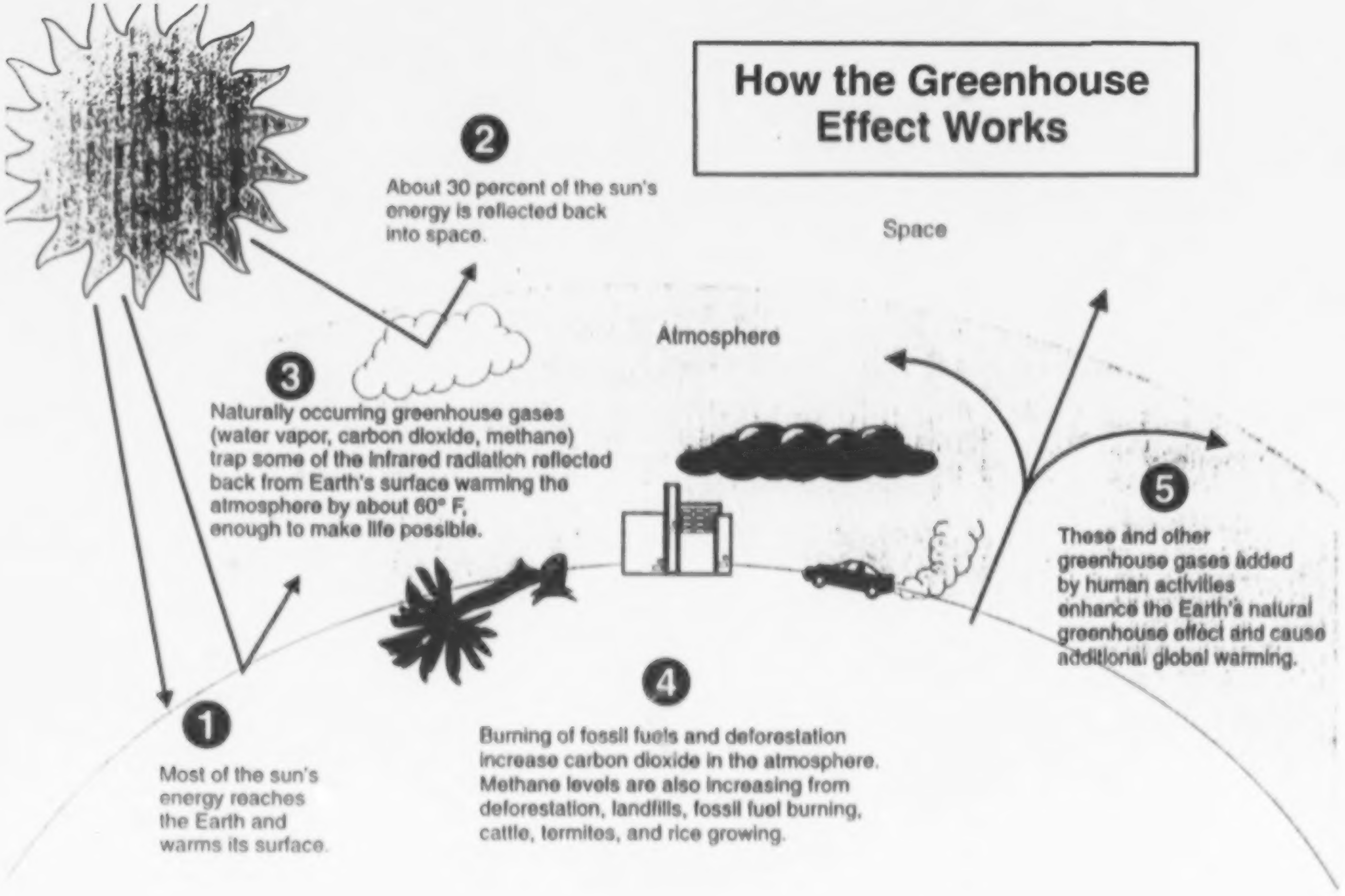
Source: United Nations Statistical Division (UNSTAT), *U.N. Energy Tape* on diskette (UNSTAT, New York, 1993).

b. Commercial Energy Consumption Per Capita



Source: United Nations Statistical Division (UNSTAT), *U.N. Energy Tape* on diskette (UNSTAT, New York, 1993); United Nations Population Division (UNPD), "Interpolated National Populations (The 1992 Revision)" on diskette (UNPD, New York, 1992).

How the Greenhouse Effect Works



❶ Most of the sun's energy reaches the Earth and warms its surface.

❷ About 30 percent of the sun's energy is reflected back into space.

❸ Naturally occurring greenhouse gases (water vapor, carbon dioxide, methane) trap some of the infrared radiation reflected back from Earth's surface warming the atmosphere by about 60° F, enough to make life possible.

❹ Burning of fossil fuels and deforestation increase carbon dioxide in the atmosphere. Methane levels are also increasing from deforestation, landfills, fossil fuel burning, cattle, termites, and rice growing.

❺ These and other greenhouse gases added by human activities enhance the Earth's natural greenhouse effect and cause additional global warming.

Computer Graphics by Susanne Kamalieh

Source: World Resources Institute, 1989.

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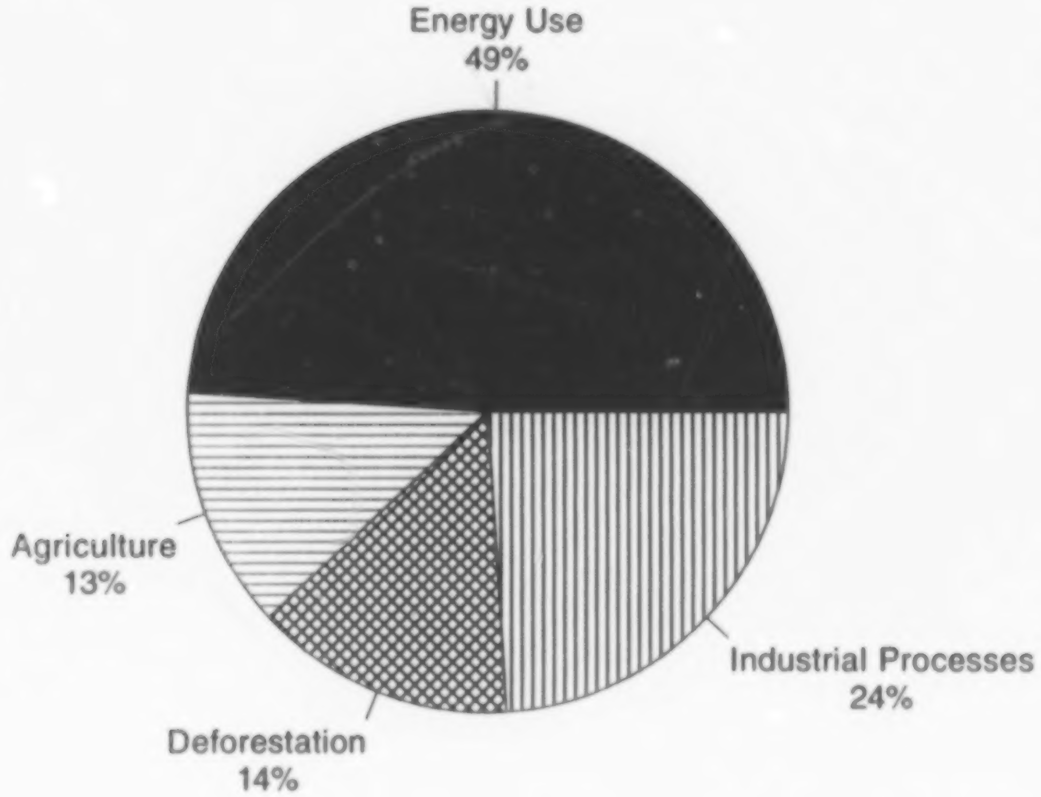
Contributions to Global Warming by Human Activity



Source: World Resources Institute in collaboration with the United Nations Environmental Programme and the United Nations Development Programme, *World Resources 1990-91* (Oxford University Press, New York, 1990), Table 2.4, p. 24.

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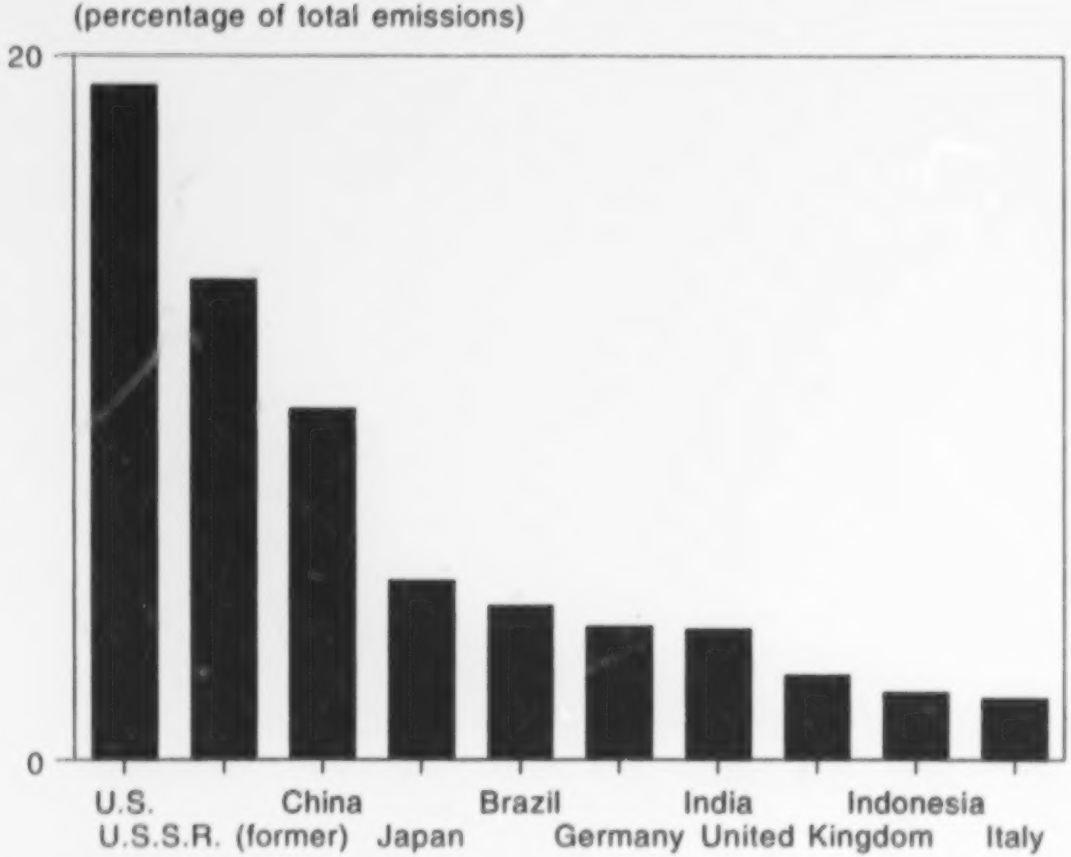
Overhead Transparency Master 13-4

Greenhouse Gas Emissions, 1991



Source: World Resources Institute

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14. ANALYZING CARTOONS ON THE ENVIRONMENT

Introduction:

According to the editors of *Discover* magazine, "the continuing debate over economics versus environment [has] provided fuel for cartoonists across the country." This lesson provides five cartoons on environmental issues for student analysis. The lesson may be used as an evaluation tool, to determine the extent to which students understand environmental issues you have presented and the positions people take on those issues. It can also serve as an interest-catching introduction to environmental issues.

Objectives: Students will be able to:

1. Identify the environmental issue presented in a cartoon.

2. Recognize the cartoonist's position on the issue.

3. Create a cartoon showing a personal position on the issue.

Subject/Grade Level: Life science/grade 7; earth science/grade 8; environmental studies/grades 9-10; biology/grade 10; current events/grades 7-12

Time Required: 1-2 class periods

Materials and Preparation: You will need copies of Handout 14-1 for all students and enough copies of Handouts 14-2 through 14-5 for one-fourth of the class to have each. You may want to add or substitute additional, more current cartoons. A recent cartoon on a topic of interest to students would be useful in introducing the lesson. Students will also need drawing materials.

Procedures:

1. Display a cartoon on a topic of interest to students. Allow students to share their views on the cartoon. Then discuss why a cartoon is an effective tool for conveying positions on current issues. Point out some of the techniques used by the cartoonist—use of symbols to convey information without many words, exaggeration or caricature, etc.

2. Tell students that they are going to be analyzing cartoons that show positions on environmental issues. Distribute Handout 14-1 and go over the questions with students to ensure that they understand how to use the handout to analyze a cartoon.

3. Divide the class into four groups, giving each group one of the cartoons. Allow time for the groups to complete questions 1 through 6 and share their findings with other groups.

Developed by Laurel R. Singleton, SSEC.

4. Next, allow students to work on their own cartoons, working either individually or in groups. Create an "art gallery" in your classroom and allow time for students to examine each others' work.

Extension/Enrichment:

Encourage students to look for cartoons on environmental issues and to add them to your class gallery. From time to time, conduct a class discussion of the cartoons, focusing on the issues covered, the positions taken, and the techniques that make the cartoons effective or ineffective in students' eyes.

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CARTOON ANALYSIS WORKSHEET

1. What objects or people do you see in the cartoon?

2. Which of the objects you listed are symbols? What does each symbol represent?

3. How do the words in the cartoon clarify the symbols?

4. What issue is the cartoonist addressing?

5. What message does the cartoon convey?

6. What groups would agree or disagree with the cartoonist's message? Explain your answer.

7. Working individually or with other students, create an editorial cartoon that shows your view on the issue the cartoonist addressed in this cartoon.

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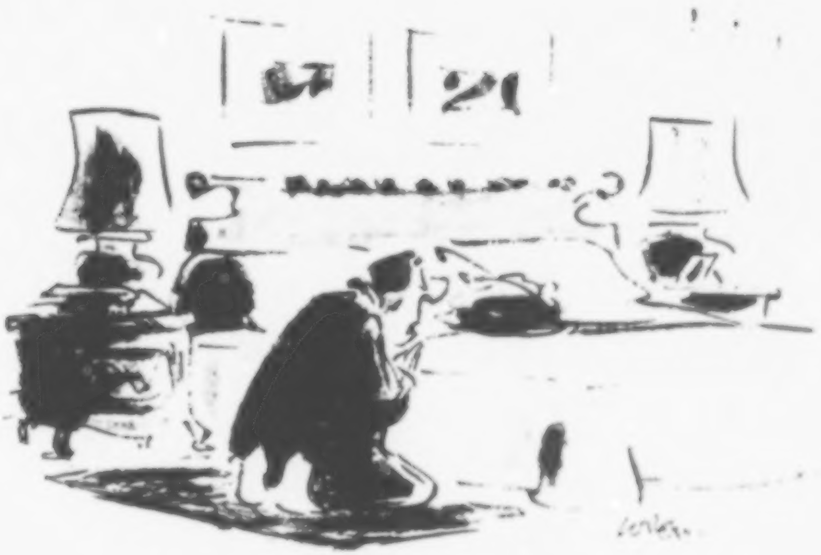
Handout 14-2

Page 1 of 1

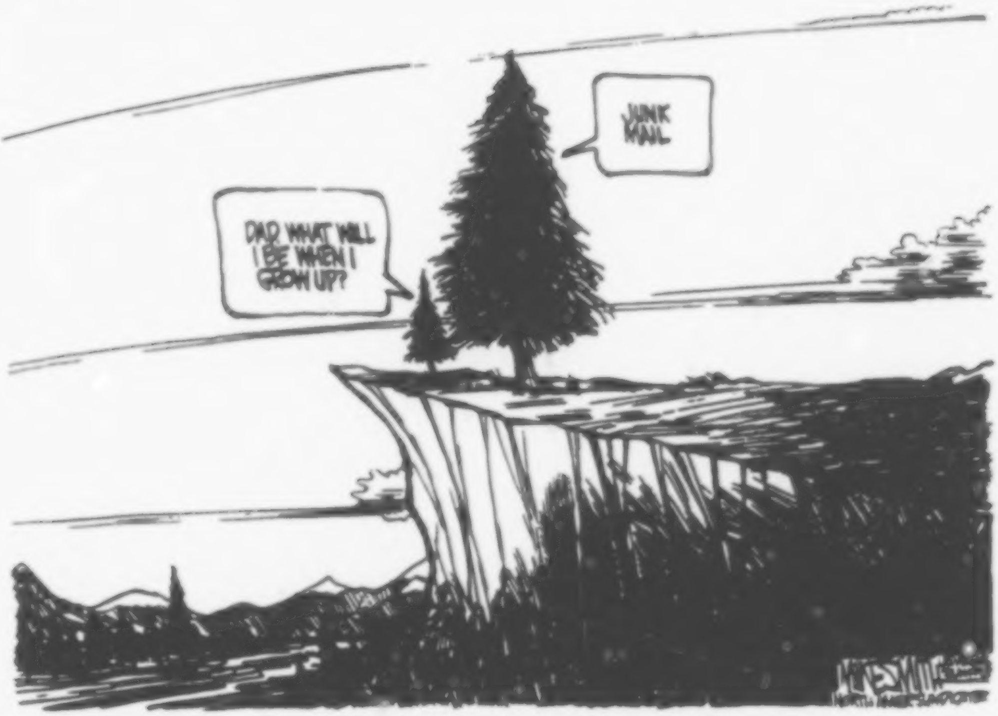


"And may we continue to be worthy of consuming a disproportionate share of this planet's resources."

Drawing by Lorenz; © 1992 The New Yorker Magazine, Inc.

Handout 14-3

Page 1 of 1


DAD WHAT WILL I BE WHEN I GROW UP?
JUNK MAIL

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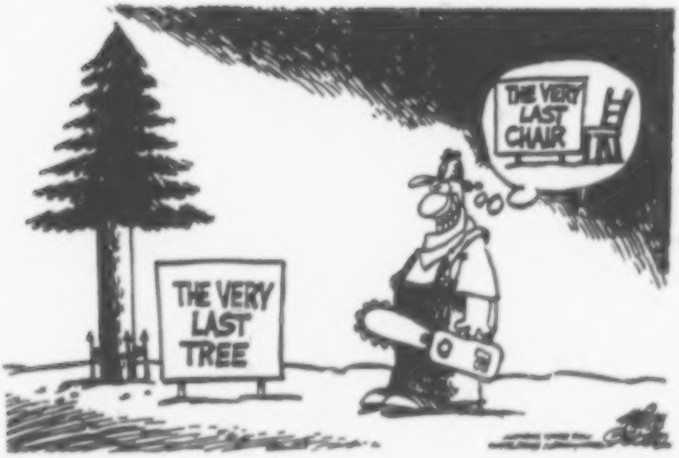
Handout 14-4 Page 1 of 1


THE VERY LAST CHAIR
THE VERY LAST TREE

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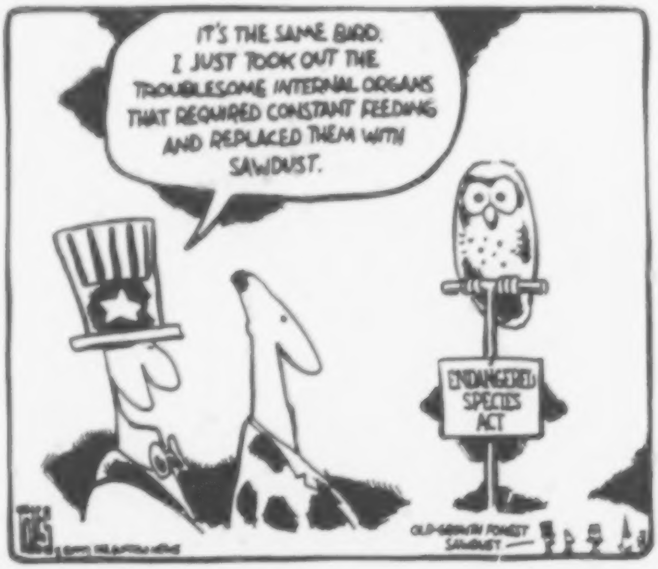
Handout 14-5 Page 1 of 1


IT'S THE SAME BIRD. I JUST TOOK OUT THE TROUBLESOME INTERNAL ORGANS THAT REQUIRED CONSTANT FEEDING AND REPLACED THEM WITH SAWDUST.
ENDANGERED SPECIES ACT
OLD-GROWTH FOREST SAWDUST
TOLES

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15. JOHN MUIR:
THE INDIVIDUAL AND THE ENVIRONMENT

Introduction:

John Muir's life provides an opportunity for students to see what one person can do when he is concerned about the relationship between people and the environment. Born in Scotland, John Muir emigrated to Wisconsin as a boy, but found his true home in the Yosemite Valley of California. Among his many accomplishments are serving as the first president of the Sierra Club and educating people around the world about the importance of preserving the wilderness. Because this lesson on Muir's life and work is centered on a biography of Muir, it can serve as a link between language arts, social studies, and science.

Objectives: Students will be able to:

1. Describe John Muir's efforts to preserve wilderness.

2. Give reasons why wilderness has value to our society.

3. Explain how humans can harm the environment, as well as actions they can take to preserve it.

4. Value the impact that one person can have.

Subject/Grade Level: Life science/grade 7; earth science/grade 8; geography/grade 7; U.S. history/grade 8

Time Required: 5-6 class periods (includes reading the biography aloud with the class)

Materials and Preparation: You will need a copy of the biography *John Muir*, by Eden Force (Englewood Cliffs, NJ: Silver Burdett Press, 1990). If multiple copies are available, students can read the book themselves; otherwise, shared oral reading will be the easiest way to manage the activity.

Procedures:

1. Tell students they are going to be reading a biography in a series called *Pioneers in Change*. What do they think that phrase means? What are the implications of putting the words *pioneers* and *change* together? Show the cover of *John Muir* and ask students to speculate on what kinds of change Muir worked for. (They should be able to guess that his work had something to do with nature.)

Adapted from *G Is for Geography*, by Laurel R. Singleton (Boulder, CO: Social Science Education Consortium, 1993).

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2. Ask students to write down some of the characteristics that they think a person would need in order to be a "pioneer in change" related to nature. What would such a person need to know? What would they need to be able to do? What would be important to that person—that is, what would their values be? Encourage students to keep their lists to compare with what they learn as they read the biography of John Muir. They may want to add things to the list or delete items from it as they read.

3. Over the course of several class periods, read the book aloud with students, concluding each day's reading with a discussion. The following questions may be useful in generating student thinking and discussion. Some could also be assigned as written exercises:

(After reading Chapters 1 and 2)

- What were the "scootchers" referred to in the title of Chapter 1. Give some examples from the book. Have you ever done a scootcher?
- Describe John's home life as a young boy. How did living in Scotland affect the way he lived? How did his father's beliefs affect the way John lived? Do you think you would have enjoyed being a member of the Muir family? Why or why not?
- Where did the family decide to move to? How did John feel about the move? What were the reasons for his happiness?
- What different forms of transportation did the Muirs use in moving to their new home? Which section of the journey seemed most dangerous or difficult? the most fun?
- What were the "wonderful glowing lessons" John learned in Wisconsin? Who taught these lessons?
- Describe John's life after the move to Wisconsin. Do you think he still thought living in Wisconsin was better than living in Scotland? Why or why not?

(After reading Chapters 3-5)

- Describe some of the inventions John took to the state fair in Wisconsin. Why do you think people were so fascinated with these inventions? What do you think John's inventions tell us about him?
- How did the Civil War change Madison? How did it change the Southern towns that John traveled to? Can you think of other examples of events that would change a place? Can you think of any events that have changed your own town? If so, how?
- Define *botany*. How did John live while he was studying botany in Canada? What kind of knowledge and skills would it take to live this way? Do you think you could live this way? Why or why not?
- What evidence did John find to support his ideas about how Yosemite Valley was formed? Draw a picture to show some of John's ideas about glaciers. How did people react when John said that the ideas of a famous geologist were wrong?

(After reading Chapters 6-7)

- What did Muir mean by his "other self"? What did his "other self" help him do?
- What made Muir worry about the wilderness, especially Yosemite? What evidence did he see that Yosemite was "doomed to perish"?
- Why did Muir begin writing about his experiences? What "moved" through John's writing? What effect did he hope his writing would have on other people? Do you think it did? Why or why not?

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- Describe some of Muir's experiences in Alaska. How was working and studying in Alaska similar to his work in Yosemite? How was it different?

(After reading Chapters 8-10)

- Why did Muir and his friends start the Sierra Club? What was its purpose? Do you know if the Sierra Club still exists today? If not, how could you find out?
- In his book *The Mountains of California*, Muir wrote about "ecology," depicting nature as a "dynamic system." Define each of these terms. Is Muir's way of thinking about nature and humans' relationship to nature similar to or different from the way we think about nature today? Explain your answer.
- Do you think Muir was right when he said that only Uncle Sam could save trees from fools? What evidence can you give to support your answer?
- Describe the Hetch Hetchy controversy. What were the different positions on this controversy? Which side eventually won? Do you agree with the decision that was reached? Why or why not?
- What were some of the last new places Muir visited in his life? Why do you think he wanted to go there? Why did his friends think he was crazy to do so? Would you want an older person that you cared for to go on such a trip? Why or why not?
- Name some of the people influenced by John Muir's work. Do you think his influence on other people is an important aspect of his life? Why or why not?

4. Ask students to refer to their original lists of the characteristics they felt a person would need in order to be a "pioneer for change" related to nature. How would they change their lists after reading John Muir's biography? Encourage students to use their lists of characteristics to write a job description for a "pioneer for change."

Extension/Enrichment:

Assign students to use the "Important Dates" at the back of the book as the basis for an illustrated timeline of John Muir's life. Each entry on the timeline should include an indication of the location in which it occurred, either through a small map showing the location or a picture showing what the place was like.

Interested students might research the work of the Sierra Club today. What kinds of materials do they produce? What kinds of projects do they undertake? What groups oppose their work? Why?

John Muir's work supported the creation of specific national parks and monuments but also encouraged the overall national parks program. Ask each student to select one national monument or park that is of interest to him/her and create a mobile that shows what makes the park or monument a special place. The locations of all the parks and monuments selected by students should be shown on a classroom map.

Have students create a "Jackdaw" for John Muir. A Jackdaw is a box containing artifacts and documents that represent the person and the culture in which he lived. The Jackdaw could be shared with other classes to give them a sense of John Muir's life and times.

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16. EXPERIMENTING WITH OVERPOPULATION

Introduction:

Through newspaper and television news accounts of poverty and famine, students may be aware of some effects of human overpopulation. They may be less aware that overpopulation also affects plants and animals. This lesson begins with a simulation that graphically demonstrates what happens to behavior in a community under the pressures of a population increase. After discussing the simulation, students take part in a planting activity to reinforce the concept of population and further develop understanding of the effects of overpopulation.

Objectives: Students will be able to:

1. Explain how overpopulation can affect animal behavior.
2. List reasons for overpopulation of animal populations.
3. Describe conditions required for maximum growth of certain plant populations.
4. Suggest ways to improve the plant population's growth and well-being.

Subject/Grade Level: Life science/grade 7; environmental studies/grade 9; geography/grade 7

Time Required: 2 class periods, with several weeks between them for students to observe plant growth

Materials and Preparation: Writing materials; 2 equal size containers for plants for each pair of students (pots or flat trays); soil; seeds (any type that germinates quickly, such as curly cress, calendula, tomato, or marigold); masking tape; a sunny window; a standard measure for water; and copies of Handout 16-1 for all students. You may skip the planting procedures and simply purchase two flats of plants and proceed from there.

Procedures:

1. Give students a writing assignment, such as the following:

> Write a three-paragraph essay on why the science of ecology is important to this planet.

2. After students have had about a minute to begin writing, interrupt them and ask a few to move their chairs and join another group at a table (or limit the space for desks), forcing them to

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Adapted from *Ecology Discovery Activities Kit*, Janet R. Galle and Patricia A. Warren, illustrated by Arek W. Galle. © 1989 The Center for Applied Research in Education/A Divison of Simon and Schuster.

form a larger population in a smaller space. Students must bring their writing assignments with them, and they must have it in contact with a desk or table when they have moved.

3. As students try to continue writing, continue to create a situation in which they feel increasingly more cramped and crowded. Remind them that their assignment is important. (Note: Be sensitive to the emotional threshold of your students. Unless students really know and trust you, some of the more conscientious students could become frustrated and overwrought by having their attempts to do the assignment thwarted.)

4. After three to five minutes, have the students stop writing. Before they return to their regular seats, discuss how they feel right at that moment. Ask questions that cause students to look at their behavior—arguing, squirming, feeling angry or upset, trying to get away, unable to concentrate on the assignment.

5. Allow students to return to their regular seats. Discuss what happens when one population becomes too large for the habitat in which it lives. What choices do individuals have in an overpopulated situation? (Die, adapt, or move)

6. Ask students what factors might contribute to overpopulation of an animal species. (Destruction of part of its habitat so that the population has less space in which to live; removal of a natural enemy of that population; human introduction of more of the species than the habitat can support) Discuss actions that humans can take to prevent overpopulation.

7. Tell students that overpopulation can also affect plants. Provide pairs of students with two plant containers, adequate soil, and seeds. Tell students to use masking tape to label one container *O* for overpopulated and one container *B* for balanced. Students should follow the instructions on Handout 16-1. (With older students, this experiment could be developed into a more complex project that examines various growth factors—amount of light, amount of water, fertilizer, acid rain effects, crowding conditions, seed varieties, ability to withstand adverse conditions, or two types of seeds in one pot.)

8. Pots should be checked daily. O and B pots should be given equal amounts of water. After germination, students should leave the O container alone, but should thin the plants in the B container after the plants have developed root systems. Thinning must be done carefully. Germination time varies; students can refer to the seed packets for more definitive data on when to thin the plants.

9. Once a week, students should measure the tallest (or several tallest) plants in each container and record the results and any comments they might have on Handout 16-1.

10. After a few weeks, depending on the growth of the plants, direct the students to answer question 5 on the handout. At this point, class time should be devoted to class discussion as to the best conditions for (1) a population's survival, and (2) a population's growth and development.

Extension/Enrichment

Encourage students to investigate whether overpopulation of plant or animal species has been a problem in your community. What caused the problem? What was the effect on the population? Did humans take action to solve or ameliorate the problem? Were these efforts successful? What actions would students recommend to prevent such problems in the future?

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EXPERIMENTING WITH OVERPOPULATION

In this experiment, you will prepare a population of plants, observe their growth, and then list the factors you think are necessary for growth and development of your plant population.

1. Plant seeds close together (about 6 per square inch) in two equal size containers. Mark one container *O*, for overpopulated, and one *B*, for balanced. Provide equal amounts of water regularly before germination.

2. After plants germinate, pull out most of the plants in the B containers so that each plant left has plenty of space around it. Do not touch the plants in the O container.

3. Continue to water regularly with equal amounts of water. Keep both containers in sunlight.

4. Check plants each week. Measure the size of the tallest plant or plants in each container. Record your comments as to the condition of plants in each container on the chart on the next page.

5. After a few weeks, answer the following questions about your experiment:

   How was the growth of the plants in B and O similar?____________________

   ____

   How was their growth different? ____________________________

   ____

   Which plants appear the healthiest? Why?________________________

   ____

   Did any plants die? If so, why do you think that happened?____________

   ____

   What do you think are the best conditions for plant growth?____________

   ____

   What biotic and abiotic factors did both sets of plants require?__________

   ____

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RESULTS OF PLANT OVERPOPULATION EXPERIMENT

	BALANCED			OVERPOPULATED		
Week #	Size	General Appearance	Comments	Size	General Appearance	Comments

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17. THE BENEFITS OF TECHNOLOGY: CONQUERING DISEASES

Introduction:

Through technological inventions and scientific discoveries, many diseases that have plagued humans since very early history are now being controlled; one disease, smallpox, has been eliminated entirely. The cost of finding effective cures or vaccines has been great.

In this lesson, students examine three major diseases from an historical perspective. They look at the scientific, technological, and social impact of each disease, as well as the role of scientists and technologists in controlling the diseases. Finally, students use the information gathered to look at a fairly new disease, AIDS, examining health concerns, economic and social concerns, and prevention.

Objectives: Students will be able to:

1. Explain how diseases are transmitted and changes in transportation technology have affected the spread of disease.
2. Describe the social impact of diseases on the world.
3. Explain why development of cures and vaccines is very costly.
4. Determine the social, scientific, and technological impact of a particular disease.
5. Determine who should be responsible for the cost of research and treatment involved with a disease.
6. Value the role of technology in helping scientists conquer diseases.

Subject/Grade Level: Biology/grade 10; chemistry/grade 11; world history/grade 10; current events/grades 10-12

Time Required: 2-3 class periods

Materials and Preparation: Make copies of Handouts 17-1, 17-5, and 17-6 for all students. Make enough copies of Handouts 17-2, 17-3, and 17-4 for one-third of the class. Prior to doing this lesson with your students, it would be wise to read through each case study (Handouts 17-2, 17-3, 17-4, and 17-5) and anticipate the questions it might elicit from students. In addition, you may wish to preplan how you will group students for the exercise.

Developed by Janice V. Pearson, Northglenn, Colorado.

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Procedures:

1. Explain to students that they will be working in groups to analyze a specific disease. Distribute Handout 17-1 and go over the questions students will answer in their groups.

2. Divide the class into three groups. Each group will be working with a different case study. If groups seem too large and unmanageable, divide the class into six groups. Each of the three case studies will then be studied by two groups. Distribute one case study to each group (or two groups).

3. Groups may want to select one person to be responsible for reading the case study to the entire group, or the groups may want to allow time prior to the discussion for each student in the group to read the case study. However this is done, each group should have one person responsible for leading the discussion on each worksheet question. Before answers are written, groups should reach consensus on their answer. Each student should complete his/her own worksheet.

4. Next, each group should select one person to give an overview of the disease that was discussed. This will help other groups learn more about the two diseases not assigned to them. The group reporter may want to use these questions to organize the presentation:

- What disease did the case study explore?
- How serious was/is the disease?
- Who was affected by the disease?
- How was/is the disease being controlled?
- How long did it take from the time the disease was identified until the disease was controlled?
- What are some important points about this disease?

5. Following the presentations, summarize this part of the activity with a discussion of the following questions:

- What are some ways in which science and technology have helped identify and control such diseases as smallpox, influenza, and poliomyelitis? (Make a class list on the chalkboard.)
- What are some of the ways in which science and technology have increased the risk of catching a serious disease? (Make a class list on the chalkboard.)
- What impact has each of these three diseases had on society?

  Smallpox Influenza Poliomyelitis

- Why do you think treatment of diseases in America moved from a reliance on "Providence" to a reliance on advanced technology?
- Why did it take so long to find a cure for smallpox and vaccines for influenza and poliomyelitis?
- Besides cures or vaccines for diseases, what are some of the benefits to society that medical research has provided? (Make a class list on the chalkboard.)
- What are some of the risks and controversies involved with medical research?

Save the information that has been listed on the chalkboard. It will be helpful during the second part of this activity.

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6. At the beginning of the next class period, review briefly the three diseases that were the focus of the first part of this lesson. Particularly go over the impact of each disease on science, technology, and society.

7. Next have students return to their small groups. Give each student a copy of the AIDS case study and discuss it. Handout 17-6 can be used to help stimulate discussion of this case study.

8. After students have discussed the AIDS case study and completed the worksheet, call the class together and conclude the activity with a discussion of the following questions:

- How is the AIDS epidemic similar to the smallpox, influenza, and poliomyelitis epidemics? (Make a list of similarities on the chalkboard.)
- Is the AIDS epidemic different from the poliomyelitis, smallpox, and influenza epidemics? Explain your answer.
- What controversies surround the AIDS epidemic?
- It took many years to develop a cure for smallpox and find vaccines for polio and influenza. It is reasonable to think we should wait about the same length of time to find a cure or vaccines for AIDS? Why or why not?
- The progress in medicine comes from much scientific and technological research. This research is very costly. Who should pay for medical research?
- Treating persons who have AIDS is also very expensive. Who should pay for this treatment?
- If persons cannot afford to pay for treatment for AIDS or any other disease, who should decide who will receive treatment and who will not?

Extension/Enrichment

Students may want to do further research about a variety of diseases. In particular, students might look at how diseases have shaped the history of the world and the United States.

You might want to invite doctors, researchers, or other medical personnel to address questions related to research on AIDS and the social, economic, and personal consequences surrounding AIDS. If appropriate for your community, you might show *And the Band Played On* (a 1993 HBO film) and discuss the issues it raises.

GROUP WORKSHEET: CONQUERING DISEASES

Which disease is your group discussing?____

As your group discusses the disease it was assigned, complete your own worksheet. Do not write an answer to any question until your group has reached agreement.

1. How did science and technology help identify this disease?

2. In what way did science and technology contribute to the promotion or spread of this disease?

3. Why were doctors cautious about collecting evidence about this disease before trying to find a way to treat the disease?

4. How do you think methods of investigation to find a cure for a disease have changed in the past 100 years? in the past 20 years?

5. How long did it take to find a cure for this disease?

6. Did this disease affect only the poor? Why or why not?

7. Did your group's case study indicate that treatment was provided for all regardless of whether they could afford treatment or not?

8. Who do you think paid for the research to find the cure or vaccine for your disease?

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SMALLPOX CASE STUDY

In mid-October 1976, a team of doctors and health workers spent 24 hours guarding four homes in the African capital of Mogadishu, Somalia. Inside the homes were the last representatives of an army that had killed more people than all the wars in history. The enemy was very tiny—only 250 millimicrons across—and numbered in the billions. When these last microscopic warriors died, smallpox was eliminated from the face of the earth.

This was a feat of monumental proportion. No other disease, not even the bubonic plague, had such an impact on the course of human events. For example, history records that one of China's greatest emperors was chosen because he alone among his siblings had already had smallpox. Smallpox is also credited with assisting the introduction of Buddhism to Japan. Even scars on the mummified head of Ramses the Fifth of Egypt indicate that this powerful ruler died of smallpox over 3,000 years ago.

Early in the Christian era, smallpox was introduced to the Western world, brought home by the Crusaders who had traveled throughout Asia Minor. Because of increased exploration and ventures into new countries and lands, from the Middle Ages onward, one death in every ten is said to have been caused by the smallpox virus. Thus, in 1520, this virus was the most potent weapon the Spanish conquistadores carried with them to the New World.

Smallpox was responsible in part for the colonizing of Massachusetts. In 1620, Miles Standish, commenting on the effect of smallpox in killing off hostile Indian tribes, wrote that "neither malaria, nor yellow fever, nor the plague, but smallpox was the blessing in disguise that gave our emigrant ancestors an opportunity to found the state." It was not long, however, before this new disease turned on the settlers. For more than two centuries, smallpox was responsible for more deaths than any other cause.

It was not until the end of the 1800s that Edward Jenner discovered the principle of vaccination with cowpox—a mild form of smallpox. This came after many years of unsuccessful attempts to isolate the virus and to vaccinate with the virus from other smallpox victims.

The disease, much like other viral diseases, had its classic symptoms. About 10 to 12 days after the virus entered a human body, the infected person became sick with a high fever and aching sensations much like influenza. After two to four days, a rash developed on the face. The rash then spread to the rest of the body within one or two days. Small, red, pimplelike bumps filled with clear serum appeared. By the fifth day, this fluid became pus. By the 10th day, scabs began to form. Although these scabs fell off in about three weeks, a disfiguring scar was often left. Some victims were left blind. Many more died.

The smallpox virus had one quality that made eradication possible. The virus must have a human to infect. Other major diseases (e.g., polio, diphtheria, cholera, tetanus, malaria, rabies, bubonic plague, and hepatitis, as well as thousands of other contagious illnesses) can survive in animals, birds, insects, or the environment, waiting to strike humans when the time is right.

Source: Adapted from "Putting an End to Smallpox," by Richard Knox, *Boston Globe* (October 6, 1976), pp. A-1, A-4. Reprinted courtesy of The Boston Globe.

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POLIOMYELITIS CASE STUDY

Poliomyelitis (polio) was first described in 1789 by Michael Underwood in a book on childhood diseases. By the late 1800s, polio epidemics began hitting the United States and Sweden. In 1916, there were 30,000 cases in the United States; thousands died.

By the 1930s, researchers had learned that polio is caused by a virus and had succeeded in transmitting the disease to monkeys. Through their work, scientists were hoping to show that infection came about when the polio virus entered the body through the nose. Ultimately, however, it was found that the polio virus most commonly is spread via direct contact or from food or water contaminated from human feces, and enters the body through the mouth and throat.

Two attempts were made in the 1930s to develop a polio vaccine patterned on Pasteur's method for making rabies vaccine 50 years earlier. But in 1935, in trials with both killed and live virus versions, the vaccines were found to be unsafe. Meanwhile, by the late 1930s, polio had killed tens of thousands of children and young adults and crippled hundreds of thousands more. However, polio epidemics were becoming more severe and more widespread.

To make a polio vaccine, scientists first had to identify the virus that caused the disease. Then they had to find a way of growing the virus outside the body—a difficult task, since viruses will grow only on selected types of living tissue that are suitable for producing vaccines.

In 1949, Dr. John Enders succeeded in growing polio viruses in monkey kidney cells grown in test tubes. After lengthy research using this new tool, investigators found that there were three strains of polio viruses.

Ender's basic research was one of the key elements that made it possible for Drs. Jonas Salk and Albert Sabin to develop safe vaccines that could be mass-produced and administered to large populations. Mass inoculation of U.S. children with Salk's killed virus vaccine began in the 1950s. A live virus vaccine developed by Sabin was proven safe and effective in clinical trials, the largest of which were in the Soviet Union. Before long, the Sabin vaccine came to be used almost exclusively in the United States. By 1965, the number of polio cases in the United States, Canada, Australia, and New Zealand had fallen to 1,000 annually, a drop of 99 percent in 12 years.

Today, even with the vast resources of modern medical technology, once children contract paralytic polio, doctors can do little more for them than provide respiratory support. Thus, it is critical that all children and adults be vaccinated against this dread disease.

Source: Adapted from "The Centuries-Old Struggle Against Infectious Diseases," by Egon Weck, *FDA Consumer* (April 1986), pp. 18-23.

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INFLUENZA CASE STUDY

Influenza (flu) is a highly infectious disease. It is easily spread by person-to-person contact. Quarantines provide little protection against the disease. The virus that causes influenza appears in three types—A, B, and C—and several sub-types. The flu virus is subject to frequent mutations. This is why it has not been possible to develop a flu vaccine that is as effective as the polio vaccines.

An influenza pandemic (an epidemic that occurs over a wide geographic area and affects a very high proportion of the population) in 1918 and 1919 spread so widely that only a few islands of the world escaped. In some communities, whole populations came down with the flu at the same time, and up to half the people died. According to medical historians, 30 influenza pandemics have occurred since 1510.

The 1918-1919 flu pandemic first appeared in April 1918 in Western France, where American troops were getting off war ships. The virus had reached England by the second week in June. By August the flu had reached Boston. In one month it spread north across the North American continent. But in Australia, where a stringent quarantine was enforced, it did not reach epidemic proportions until February 1919. Some suggest that it even spread to animals, including baboons in South Africa and hogs in the United States.

In 1940, Sir Frank Macfarlane Burnett succeeded in growing the flu virus in the chick embryos of fertilized eggs. Flu vaccines continue to be made from viruses grown this way. The viruses are harvested from the egg fluid and then inactivated. The first line of defense against influenza continues to be the vaccine, which is estimated to be 70 to 90 percent effective. By careful investigation and watch, public health authorities can catch mutations of known viral strains. Then vaccines can be produced to protect persons at high risk during flu epidemics.

An example of this was seen in the United States in 1957. On April 17 of that year, an article in the *New York Times* reported that thousands of children in Hong Kong were being treated for high fevers and influenza symptoms. American doctors suspected that this was an outbreak of a new variety of flu.

Researchers contacted Army authorities in Hong Kong and asked them to send swabbings from the throats of flu victims. Within a month after the report was spotted in the newspaper, the virus specimens arrived; in five days, a new flu virus, A2, had been isolated.

Pharmaceutical manufacturers worked quickly to produce a vaccine that would protect against the A2 flue virus in time for the start of the autumn flu season in the United States. Although in 1957 alone, nearly 19,000 Americans died from the A2 (or Asian flu), the vaccine greatly reduced the severity of the pandemic and prevented a major health catastrophe.

Today, the drug amantadine is also useful in preventing flu. No vaccines have yet totally eliminated this disease. Antibiotics can be given to treat bacterial infections that often accompany the flu during epidemics. When left untreated, however, such infections contribute substantially to the mortality of flu victims.

Source: Adapted from "The Centuries-Old Struggle Against Infectious Diseases," by Egon Weck, *FDA Consumer* (April 1986), pp. 18-23.

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OVERVIEW OF THE AIDS VIRUS AND RELATED ILLNESSES

AIDS is a disease caused by a virus that attacks the body's immune system. The virus, called the Human Immunodeficiency Virus (HIV), entered the United States in the late 1970s. Scientists and researchers were first alerted that something was awry in 1979, when a number of young males began dying of once-rare diseases. In these patients, the immune system had mysteriously broken down, leaving them vulnerable to any bacteria or infection. Soon, as more and more of these cases were reported, the Centers for Disease Control (CDC) began an effort to understand what was happening. In 1981-82 they announced the presence of a new disease in the population, labeling it "Acquired Immune Deficiency Syndrome," or AIDS.

AIDS initially was almost exclusively confined to the male homosexual community, intravenous (I.V.) drug users, and individuals who received blood transfusions. The reason for this is that AIDS can only be spread through the actual sharing of blood and bodily fluids such as semen and vaginal fluid. There are *no* cases of AIDS being transmitted through such casual contact as sharing bath towels, sharing a can of pop, cooking, shaking hands, or kissing on the cheek. Although the AIDS virus has been found in saliva and tears, there are no cases of saliva or tears alone causing a case of AIDS. It is thought that the concentration of the virus in these fluids is not high enough for transmission to another individual. The only examples of health care workers acquiring AIDS on the job involve direct contact with contaminated blood through open sores on the health worker or by accidental needle punctures.

The AIDS "risk groups" have changed since the early 1980s. Now, they include male homosexuals, I.V. drug users, sex partners of I.V. drug users, and children born to I.V. drug users. Infection rates among women, especially poor and minority women, are rising rapidly. The risk of contracting AIDS through blood transfusions has been reduced since the early 1980s because blood is now screened for the AIDS virus.

The statistics below give an idea of how rapidly the AIDS epidemic has spread.

	U.S. Cases	**World**
1981	314	20,000 (est.)
1982	1,446	250,000
1983	3,901	500,000
1984	7,863	1,000,000
1985	14,766	
1986	38,689	4,000,000
1987	48,825	7,000,000
1988	91,618	
1989	1149,705	11,000,000
1990	227,670	
1991	351,715	14,000,000 (est.)
1992	1,022,784	18,000,000 (est.)

Source for statistics: World Health Organization and Centers for Disease Control.

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1995	3,050,000 (est.)	
2000	5,200,000 (est.)	20,000,000-101,00,000 (est.)

Individuals do not die from AIDS. Instead, they die because their immune system no longer is able to fight off life-threatening diseases. The AIDS virus enters the human body and locates the helper T-cells, a type of lymphocyte, in the immune system. Without helper T-cells, the human body is open to attack by viruses, bacteria, or other infections. The AIDS virus is able to enter the healthy helper T-cell and, using an enzyme called "reverse transcriptase," is able to make the helper T-cell reproduce more of the AIDS virus. The virus then spreads from the cell to infect more and more helper T-cells. This results in a defective immune system and the spreading of more and more of the AIDS virus. Scientists are, at this point, unable to explain how long it takes for the AIDS virus to begin to take over the immune system, but it appears to be anywhere from several months to several years.

Individuals who have been exposed to the AIDS virus fall into one of three categories at any given time. The majority will test positive through a test called the ELISA, which tells whether a person has developed antibodies to the AIDS virus. This means that they have been exposed to the AIDS virus and it exists within their body. A second group will develop AIDS-Related Complex, or ARC. Those with ARC have weakened immune systems and suffer from such symptoms as chronic swollen lymph glands, diarrhea, night sweats, and lingering infections. Some individuals with ARC die from these diseases. The final category is known as "full-blown AIDS." These individuals suffer from any number of "opportunistic diseases"—that is, diseases that take the opportunity of a weakened immune system to invade the body. The two most common "opportunistic diseases" are Pneumocystis Carinii Pneumonia (PCP), a lung disease caused by a protozoa, and Kaposi's Sarcoma (KS), a form of skin cancer.

On the average, a person shows symptoms 8 years and 4 months following infection with HIV. This figure helps explain why few teenagers have full-blown AIDS. The symptoms of the disease will not manifest themselves until infected teenagers reach their 20s.

Agencies like the Public Health Service have emphasized the importance of education in preventing the spread of AIDS. They recommend avoiding the following risky behaviors:

- Sharing drug needles and syringes.
- Anal sex, with or without a condom.
- Vaginal or oral sex with someone who shoots drugs or engages in anal sex.
- Sex with someone you don't know well (a pickup or prostitute) or with someone you know has several sex partners.
- Unprotected sex (without a condom and spermicide) with an infected person.

At present, there is no cure for AIDS. Some drugs have prolonged the lives of people with AIDS, and work on other treatments continues. No vaccine to prevent uninfected people from getting the infection has been developed. In fact, researchers believe it may take many years for an effective and safe vaccine to be developed.

While researchers search for treatments and vaccines, the AIDS epidemic is straining the health care system, especially in parts of the country where AIDS is prevalent. The cost of hospitalization is high and many AIDS patients have lost their health insurance, either because their illness made it impossible for them to continue working or because they were underinsured. These patients are then covered by Medicaid, creating a large cost for U.S. taxpayers.

AIDS WORKSHEET

After your group has read and discussed the AIDS case study, complete this worksheet.

1. How is the AIDS epidemic similar to the smallpox, influenza, and poliomyelitis epidemics?

2. How is the AIDS epidemic different from the smallpox, influenza, and poliomyelitis epidemics?

3. What impact has the AIDS epidemic had on each of the following?
   - Science

   - Technology

   - Society

4. What should we do as individuals to protect ourselves against the AIDS virus?

5. What can we do as individuals to help persons who have the AIDS virus?

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18. GENETIC SCREENING

Introduction:

Progress in medical genetics has increased our specific knowledge about genetic disorders. New screening tests help geneticists identify at-risk individuals. Depending on the nature of a disorder and its impact on the individual, genetic screening may take place at or shortly after birth, during childhood, or during adulthood. As more and more genetics tests become available, the ethical issues related to screening are increasingly complex. In this lesson, students are introduced to the idea of genetic screening and learn how it is different from other kinds of medical screening. They then apply a decision-making model to two case studies involving genetic screening and reproductive risks, a traditional focus of genetic counseling. Other newer issues are described in the **Teacher Background Information**. Because advances in this field are occurring very rapidly, teachers should update this information periodically.

Objectives: Students will be able to:

1. Define genetic screening.

2. Describe how genetic screening differs from screening for other health problems.

3. List some problems that can arise from genetic screening.

4. Apply a decision-making model to a case study involving genetic screening.

5. Value the contributions of scientists in making genetic screening available to carriers of disorders transmitted from one generation to another.

Subject/Grade Level: General science/grade 9; biology/grade 10; current events/grades 9-12

Time Required: 1-2 class periods

Materials and Preparation: Make copies of Handout 18-1 for all students; make enough copies of Handouts 18-2 and 18-3 for the groups to which you intend to assign each case study.

Procedures:

1. Use the **Teacher Background Information** to introduce the concept of genetic screening. Ask the following questions to determine whether students understand the major points:

- What is genetic screening?
- Why is genetic screening important?
- How is genetic screening different from other kinds of medical screening?
- What problems could arise from genetic screening?

Adapted from *Biomedical Technology* (Dubuque, IA: Kendall/Hunt, 1984). © 1984 by Biological Sciences Curriculum Study. Reprinted by permission of BSCS.

2. Tell students that people who have had genetic screening and found that they are carriers of genetically transmitted diseases face important decisions. Pass out copies of Handout 18-1. Go over the steps in the decision-making model.

3. Tell students they will have a chance to apply the decision-making model to two case studies involving genetic screening. Divide the students into groups of five or six. Depending on the time available, you may have each group do only one case study or do both. Distribute handouts 18-2 and 18-3. Tell the groups to review the assigned case study(ies), discuss the facts of the case(s), and use the decision-making model to decide on a course of action. A reporter should be appointed within each group (if each group is doing both cases, a reporter should be appointed for each case).

4. After groups have reviewed their cases and determined a course of action, call the class together and let each group report.

5. After each group has reported, use the following questions to debrief the activity:

- How did the final decision of each group compare with individual recommendations? Did the group compromise or did one point of view dominate?
- Why is genetic screening important?
- Should genetic screening be a requirement before persons could get married or have children? Why or why not?
- How could this decision-making model be used with other life situations? What are some examples?

Extension/Enrichment

This activity can be extended by introducing the issue of confidentiality. Provide each student with a copy of Handout 18-4. Have them read "What is Confidentiality?" Then ask each student to choose one of the situations and write a paragraph answering the following questions for that situation:

- What is the issue?
- Who is involved in this issue?
- What are the risks involved with this issue?
- What are the alternatives available to the counselor?
- What are the costs and benefits of each alternative?
- What do you think the counselor should do? Explain your answer.

Have students do research on PKU and its treatment. Is this a technological success story?

Teacher Background Information:

Note to Teachers: Advances in medical genetics are occurring at a rapid pace. The following information presents a few of the issues related to genetic testing at the time of this writing. Teachers should update their information periodically to ensure that the activity remains current.

Genetic screening is the testing of people to see whether they have genetic characteristics that could harm themselves or their descendants. Some screening takes place at or shortly after birth.

For example, newborns in the United States are routinely screened for phenylketonuria and hypothyroidism; many newborns are also screened for sickle cell anemia. When one of these conditions is detected, doctors can prescribe appropriate treatments. A more controversial practice is testing newborns for conditions that are not treatable. In such cases, knowledge of the condition does not change its course. Some ethicists therefore question whether such screening should be done.

Screening may also occur in adulthood. Such screening often involves disorders—such as sickle cell anemia, thalassemia major, and Tay-Sachs disease—that are transmitted from one generation to another as recessive traits. In such cases, two parents with the recessive trait could give a child two abnormal genes, meaning the child would have the disorder. Carrier tests are available for many recessively inherited disorders.

Following screening for such disorders, individuals can have what is called prospective counseling. Prospective counseling is done when an individual is planning to be married or a couple is planning to have a child. People who receive such counseling can make better decisions about having children. They may decide, for example, not to marry another carrier, not to have children, or to have artificial insemination by a donor who is not a carrier.

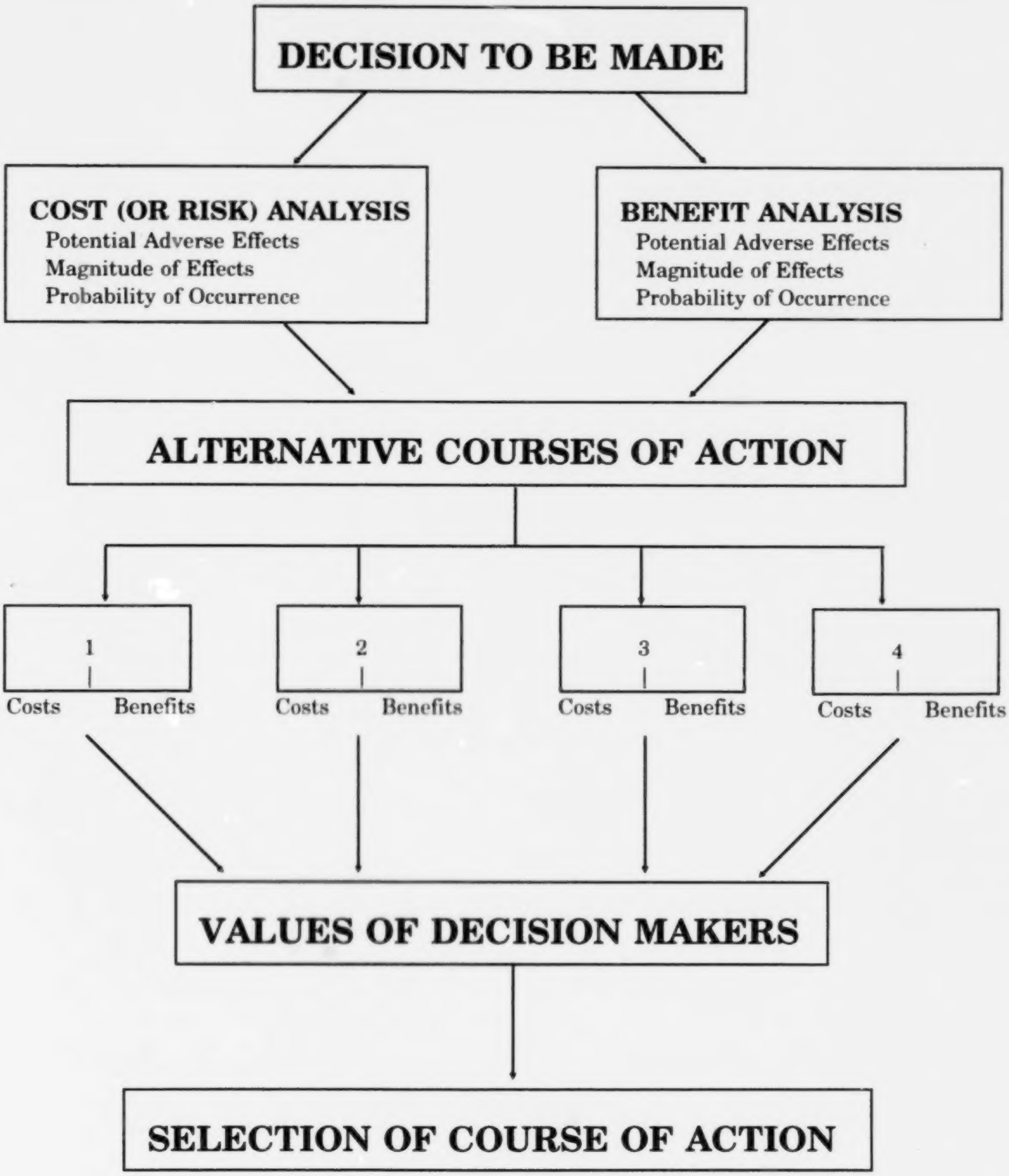
Screening is now available to predict whether a person will get a disease that occurs later in life, such as Huntington's disease. Such screening raises questions regarding the availability of counseling that can help a person cope with the knowledge that he or she is likely to develop Huntington's, a disease with severe social and psychological effects, as well as devastating physical results.

Another relatively recent development that is raising new issues is the linking of particular genes with susceptibility to such diseases as breast cancer and colon cancer. Since many other factors contribute to these diseases, however, the predictive value of screening for these genes is questionable. Thus, some geneticists question their widespread use for preventive health care purposes. To use this type of genetic information judiciously, patients and their family members will need considerable counseling. Other experts worry that such tests will prevent people with genetic susceptibilities to certain diseases from getting health or life insurance.

Genetic screening is in some ways different from most other types of medical screening, such as that for infectious diseases. In genetic screening, the conditions being screened for have generally been very rare (although as advances are made in genetic medicine, more common conditions are likely to be subject to genetic screening as well). In addition, in nongenetic screening, the individual being screened is the individual who is to be protected. In genetic screening, protection is often not only for the individual being screened, but for others as well— prospective offspring, siblings, or other relatives. This fact can raise question[illegible] the genetic counselor, who must weigh the duty to protect patient confidentiality with the re[illegible]iblity to warn innocent third parties of potential harm. Often, decisions resulting from use [illegible]c screening involve two people, who may have different views on how the information sh[illegible]sed. Because genetic screening identifies a disorder that is part of the individual's biological make-up, the person may feel a loss of self-esteem or guilt about carrying the disorder.

Good counseling can help those individuals identified as carriers realize that their feelings of guilt or inferiority are unfounded. It can also identify for people the options available to them. In the case of treatable diseases, counseling is more directive, in that particular treatments are indicated if a person has a specific condition.

A DECISION-MAKING MODEL


DECISION TO BE MADE
COST (OR RISK) ANALYSIS
Potential Adverse Effects
Magnitude of Effects
Probability of Occurrence
BENEFIT ANALYSIS
Potential Adverse Effects
Magnitude of Effects
Probability of Occurrence
ALTERNATIVE COURSES OF ACTION
1
Costs
Benefits
2
Costs
Benefits
3
Costs
Benefits
4
Costs
Benefits
VALUES OF DECISION MAKERS
SELECTION OF COURSE OF ACTION

CASE STUDY I

Mark Fulcher is a 23-year-old black student at a large university. The genetics unit at a local hospital conducted a sickle cell screening program on campus, and Mark was tested. The simple blood test involves the detection of sickle hemoglobin, using electrophoresis.

Hemoglobin A differs from hemoglobin S—sickle hemoglobin—by one amino acid. In HbS, valine is substituted for glutamic acid at the position of the sixth amino acid. This changes the electrical charge of the hemoglobin molecules. The change can be detected by electrophoresis. If the test shows a pattern of all HbA, the person is homozygous for normal hemoglobin and does not have the gene for HbS. If the person's blood shows HbA and HbS, the person has one gene for each hemoglobin type. Those persons are heterozygotes and have sickle cell trait. If the test shows all HbS, the person is homozygous for sickle hemoglobin—that is, he or she has two genes for sickle hemoglobin. Such persons have sickle cell anemia. Persons with sickle cell trait generally experience no ill effects.

Trait carriers can, however, pass the sickle cell gene on to their offspring. When Mark received the news that he had sickle cell trait, he made an appointment with a counselor at the genetics unit.

Mark was informed that his carrier status had important implications for decisions concerning marriage and childbirth. He was told that if he married another carrier, there was a 25-percent probability with each pregnancy that the child would have sickle cell anemia. In addition, Mark learned that his younger brother and sister also were at risk for being carriers, since at least one and perhaps both of his parents were carriers.

Mark informed the counselor that he was engaged to a young black woman and that the wedding was to take place in six months. The counselor suggested that Mark inform his fiancee of his carrier status, since she should be aware of the situation and should herself be tested. It was also important, the counselor asserted, for Mark's parents to tell his brother and sister, as well as other relatives, so that they all could be tested.

Mark steadfastly refused, saying that everyone would think he was "defective." He was afraid that his fiancee would call off the wedding and that his family would hate him for revealing that they might all be "defective."

What action should the counselor take?

CASE STUDY II

Tay-Sachs disease (TSD) is most common among Jewish people who trace their ancestry to Eastern Europe. Children born with TSD are missing an enzyme called hexosaminidase A (Hex-A). The genes that are supposed to produce the enzyme do not work properly. The affected children inherit one defective gene from each parent. The parents are unaffected, because they have one gene that is functioning normally. That gene produces enough Hex-A to prevent any ill effects.

Because they lack Hex-A completely, affected children cannot break down a certain group of fats in the body. Those fats build up in the nerve cells of the brain and prevent those cells from working properly. The disease is always fatal; children born with TSD rarely live past the age of four.

A screening test can detect a person who is a carrier. A simple test can measure the level of Hex-A in the blood. Carriers will show a level of Hex-A that is in between the "normal" and affected levels.

Craig and Roberta Robinson had never been screened for Tay-Sachs. However, their first child, Kerry, had the disorder. She died when she was 22 months. Both Craig and Roberta were devastated by the experience.

Four years have passed, and Roberta would like to have another child. The counselor has told the Robinsons that the chances are one in four that another child will also have the disorder. Craig says that the risk is too high. He cannot face the possibility of suffering through the death of another child.

What should the Robinsons do?

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SCREENING AND CONFIDENTIALITY

What Is Confidentiality?

Doctors have long adhered to a code of ethics that calls for confidentiality. This means that information about patients cannot be disclosed to third parties. Many states even protect confidentiality in court, when the patient objects to the doctor's revealing the information. These laws illustrate that information shared with a doctor is subject to the patient's control.

Counselors, who deal with very sensitive information, are also expected to keep information confidential. Information from genetic screening, however, can indicate that some of the relatives of the person being screened are at risk. Thus, it is argued, confidentiality cannot be as strict in the case of genetic screening information.

Situation 1:

Jimmy, a four-year-old boy, has been diagnosed with hemophilia, an inherited condition in which the blood fails to clot quickly enough, causing prolonged and uncontrolled bleeding from even the smallest cut. This disease appears in males but is carried by females. Because Jimmy's mother has been diagnosed as a carrier of hemophilia, the genetics counselor is afraid that the mother's female relatives, particularly her three sisters, are also carriers of this disorder.

During counseling, Jimmy's mother refused to let the counselor contact her three sisters. Should the counselor be permitted to override this objection?

Situation 2:

Amniocentesis is a method used to diagnose genetic diseases before a child is born. Down's syndrome is one disease that can be detected in this way. Babies born with Down's syndrome are mentally retarded and often have other physical problems. The results of amniocentesis are more than 99 percent accurate.

Betty and Brian have been married for one year. Both are looking forward to raising a family. Betty is 16 weeks pregnant and has amniocentesis done. The results indicate that her unborn child will have Down's syndrome. The doctor suggests that Brian come in so the doctor can explain the disease more fully to both Betty and Brian. Betty refuses to tell Brian or let the doctor tell Brian because she is afraid Brian would want her to terminate the pregnancy. What should the doctor do?

19. WHAT'S IN THE CLASSROOM AIR?

Introduction:

Indoor air quality is determined by the presence of contaminants. Particulates, or minute separate particles, produced outdoors work their way into indoor environments when drawn into ventilation systems, blown in through drafty openings, wafted in through open windows and doors, and carried in by people. Particulates produced indoors may result from the abrasion of physical objects, such as the opening and closing of windows and doors. Building materials can also release toxins. When trapped within a building, moisture too can increase the overall populations of molds and bacteria. Buildings and their ventilation systems are designed and operated to ensure occupants' comfort; however, when the systems do not work as well as they should, poor indoor air quality may occur. The resulting contaminants may cause occupants, especially those with respiratory problems, to suffer headaches, dizziness, or fatigue.

In this activity, students begin to explore what particulates are, where they come from, their shapes and densities, and—most important—what particulates imply about the environmental health of an area.

Objectives: Students will be able to:

1. Collect and analyze data about particulates in the air in your classroom.

2. Make observations and hypotheses about air quality in your classroom based on the data available.

Subject/Grade Level: Any science class/grades 7-12; current events/grades 7-12

Time Required: Approximately 3 class periods, with two weeks between the first and second classes

Materials and Preparation: Make copies of Handouts 19-1 and 19-2 for all students. Gather the following materials: 1 mm x 1 mm graph paper, clear adhesive tape, knife, four 100x microscopes, overhead transparency, paper, paper clips, scissors, thread (black and white), and white chalk. You will also need to prepare slides of common particulates for students to compare their collections with; possibilities include pollen, human skin and hair, and carpet dust. If possible, arrange for other classes to conduct this activity with you and your students. With other participants, you can compare your results to gain a better understanding of the indoor air quality at your school.

Adapted with permission from "What's in the Classroom Air?" by Hamilton Gilbert, *Hands-On!* (Fall 1993). Published by TERC, 2067 Massachusetts Avenue, Cambridge, MA 02139.

Procedures:

1. Ask students how they can tell if the air outside is dirty. (Limited visibility or brown-looking air) Next, ask: Does the visibility in our classroom tell us anything about air quality indoors? (No) How could we determine if there are particles in the air indoors? Allow some time to discuss the suggestions students give. Then explain that in this lesson students are going to be collecting particle samples to measure the amount of particulates using different parameters.

2. Divide the class into four groups. Each group is to create a particle collector and prepare a standard microscope slide. Directions for both activities are given on Handout 19-1. Each team is responsible for its collector, from construction to placement, collection, examination, and analysis.

3. With students, place the collectors in the following locations:

- Location 1, the center of the classroom floor at a height of 1.2 meters.
- Location 2, the classroom ventilation inlet.
- Location 3, the classroom ventilation outlet.
- Location 4, an open outdoor location 50 meters from the school building.

All four collectors should be left exposed and undisturbed for two weeks.

4. After two weeks, have the groups collect their particle collectors. Explain that students will be examining the particles in three stages: first counting particles, then identifying their shapes, and then comparing them with a gray scale.

5. Provide each group with a 100-power microscope and graph paper, which they will need to calculate the number of particles per square millimeter on the particle collectors. Each group's results should be shared with other groups and the data should be recorded on Handout 19-2, which also provides instructions for this analysis.

6. Next, ask students to identify what they think the most common particulate in your classroom is. If you and your students use a blackboard, it is quite possibly chalk dust. Other common particulates include carpet dust, human skin and hair, pollen, cleaning products, paint chips, tire tread, and clothing fibers.

7. Have students compare the shapes of the particles they collected with those of the chalk dust and thread they placed on their prepared slide. Also make available for comparison any slides of common particulates you have prepared. The comparison slides will help students identify particles from known sources. Again, results should be shared across groups and recorded on Handout 19-2.

8. The gray scale number indicates a low to high presence of particles. As a cell matches a darker shade, it reflects a higher density of particles per square millimeter. Have students visually examine a cell and compare it with the shades on the gray scale. Data should again be compared and recorded.

9. Have students examine the completed data table. Use the following questions to guide a discussion of the results:

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- Are there any conditions that may have contributed to our results, such as strong winds outside or operation of machinery, construction, or chemical cleaning inside during the sampling period?
- By count, which location had the highest average number of particles? What is present at that location compared with the others?
- By shape, which is the most frequently noted form among the locations? How do the shapes recorded indoors compare with those found outdoors?
- By gray scale, which location showed the highest density of particles? What might cause the difference in density readings?
- Overall, what do the results indicate about air quality in our classroom? What are your hypotheses or conclusions?
- What might be done to improve air quality in our classroom? (Seal wall or floor cracks, clean the classroom more regularly, install new filters in the ventilation system, close all chemical products properly)

10. If other classes in the school conducted the activity, discuss the similarities and differences found in the data, as well as whether the indoor air quality at your school might be improved for everyone.

Extension/Enrichment:

If students concluded that the air quality in your classroom could be improved, encourage them to take action to do so. Conduct the activity again later in the year to see whether the students' actions were effective.

Students may also want to collect particles in various locations in their homes. Allow time for them to analyze the results in class.

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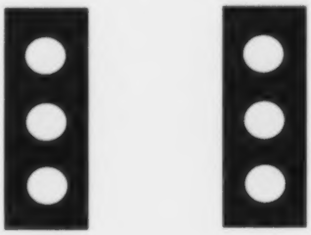
Handout 19-1

DIRECTIONS FOR CONSTRUCTING A PARTICLE COLLECTOR

Your group is to construct a three-windowed airborne particle collector. First, cut two pieces of paper (15 x 5 centimeters) and make three vertically aligned windows (2 cm in diameter) in one strip. Cut a strip of clear adhesive tape and place it on the paper with the windows so that the sticky side is exposed through all three. Use clips to attach the other piece of paper to the back of the first piece. Over time, dust will collect on the sticky surface.



Your group should also prepare a standard microscope slide. Cut a 2 cm x 4 cm piece from a sheet of overhead transparency. Use a knife to scrape white chalk dust onto one half of the slide. Place two pieces of thread, one black and one white, on the other half. Cover the slide with clear adhesive tape.

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DATA COLLECTION SHEET

Location	**Center of Classroom**	**Classroom Inlet**	**Classroom Outlet**	**Outside**
Number				
Shape				
Density				

Counting Particles

1. Remove the back sheet of your collector and use a marker to circle parts of the tape exposed to dust.

2. Place graph paper on a table and carefully place the adhesive side of the tape on the graph paper.

3. Turn on the microscope light and place the lens directly onto the circled part of the tape so that you can see an entire cell of the graph paper in your field of view. Each cell is one square millimeter.

4. Count the number of particles visible within this one cell and record the number on a piece of paper. Perform this procedure on four randomly chosen cells within each window, and calculate the average for this location. Record your average in the data table. Share your results with the other groups.

Comparing Shapes

1. Compare the shapes of the particles in your collector with the shapes of known types of particles (chalk dust, thread, other items your teacher prepared).

2. Record all the shapes that you see, using the typical shapes shown below. Record the number 7 if the particles fit none of the first six shapes.

3. On your data table, record the most common shape. Share the information with the other groups.

★	✹	●	■	▬	▲	?
1	2	3	4	5	6	7

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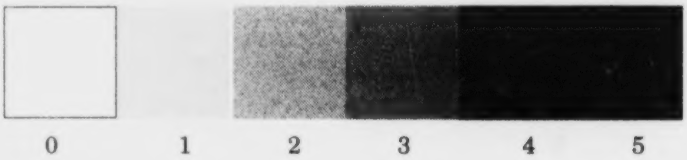
Using the Gray Scale

1. Visually compare each window of your particle collector with the gray scale. Record the segment number that is closest to the density apparent on the tape.
2. Calculate the mode (the most frequently recorded response) for this location.
3. Record and share your data.



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20. IT'S A NATURAL!

Introduction:

Americans seem to be increasingly health conscious. Eating patterns have changed, as "natural" foods have gained in popularity. Food producers have been quick to recognize and follow that trend. New foods, as well as new styles of existing products (flavored yogurt, light beer), have appeared. In this lesson students examine the validity of some health food claims.

This activity makes a good introduction to a unit on government control of industry and/or one on advertising techniques. It will work best if you begin discussion on a Friday so that students will have time over the weekend to collect samples for the homework activity.

Objectives: Students will be able to:

1. Give examples of "natural" foods, both processed and unprocessed.
2. Identify ingredients used in food products.
3. Critically evaluate advertising claims.
4. Value the knowledge and skills of a nutritionist.

Subject/Grade Level: Life science/grade 7; physical science/grade 9; chemistry/grade 11; current events/grades 7-12; economics/grade 12

Time Required: 1-2 class periods plus homework time

Materials and Preparation: Make copies of Handout 20-1 for all students. You may want to arrange for the home economics teacher or school dietitian to take part in the concluding discussion.

Procedures:

1. Start by having students think of their favorite foods. Across the top of the chalkboard, write these three column headings—I, II, III. The columns represent these categories: I="natural" or unprocessed foods; II=foods subjected to some processing; III=substantially processed foods. Do not reveal what the categories are yet. Ask students to call out their foods. As they contribute, write the items in the appropriate categories. The exact categorization is not critical, but as a guideline, category I would include those foods sold and eaten with nearly no processing, such as lettuce or potatoes. Category II foods would be slightly more processed—apples might fit here, as they are waxed and polished before sale; oranges are also dyed and waxed. Category III contains nearly all canned or bottled foods.

Developed by Robert D. LaRue, Jr., Boulder Valley (CO) Public Schools.

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2. After recording 20 to 30 foods, have students decide how they would label each category. What do the foods in each column have in common that might provide a good label? Students will probably propose a wide range of labels, some of which will be quite appropriate. Validate those contributions by exploring student perceptions of why those labels might work. Finally, add the labels you had in mind. Note how they agree/diverge from student proposals.

3. Ask students what criteria they would use to distinguish between categories I and II. How "processed" can a food be and still be "natural"? What does "processed" mean? What is "natural"?

4. Next, ask students what products they can think of that claim in their advertising to be "natural." How believable is that claim? Why would advertisers make that claim? What products do you buy because they are "natural"?

5. Assign the homework project. Students are to find two foods that are advertised as "natural" or as containing only "natural ingredients." Students should either write down all the ingredients or bring the labels into class on Monday. Another option is for students to videotape an evening of television and extract any commercials promoting natural products. The actual labels for those products should be found and compared to the advertising. Students should indicate, in writing, whether each product deserves the "natural" label and whether they would recommend buying the product.

6. At the beginning of the next class period, have students share their discoveries and concerns.

7. Tell students that the class is going to concentrate on some of the additives they found on labels. Distribute Handout 20-1 and allow time for students to read it.

8. Go over the information in the chart. Ask students to give examples of foods with each type of additive. For example, nutrients are added to most breads. The enriched flour in bread often contains niacin and iron.

9. Review the nitrite controversy. Ask students to brainstorm a list of questions that should be researched to help solve this dilemma. Also ask students what they can do personally until the nitrite dilemma is solved.

10. Divide the class into groups of three to four students. Ask students to select from all the food labels in the group, five additives that are not found naturally in foods. The group should list the food additives in a chart similar to this example:

	Food Product in Which Additive Was Found	Purpose of Additive	Other Information About Additive
1. Additive #1			
2. Additive #2			
3. Additive #3, etc....			

11. Next, ask groups to compare similar kinds of foods, such as three cereals or three soups. Do the products in each category contain the same food additives? Do some contain fewer food additives?

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12. Bring the class back together and ask each group to report on the kinds of additives it found. A class list of food additives can be made on the chalkboard, with hash marks used whenever the same food additive is mentioned.

13. Conclude the activity with the following questions (having the dietitian or home economics teacher available for this discussion would be helpful):

- Why are food additives used?
- Which food additives that you found do you think should be added to food?
- Is it possible to buy the same kind of food product without additives? Give examples.
- Are there differences in prices between foods with additives and the same foods without additives?
- What must a person allergic to certain food additives do to avoid those additives?
- How extensive should testing of food additives be? Should the consumer be willing to pay higher food prices to ensure that proper testing is done?
- Should food additives be prohibited, since all food additives are unnatural additions to our foods?
- Both the use of food additives and laws protecting the quality of foods have increased since the early 1900s. What societal changes might explain these trends?

Extension/Enrichment:

Have students look in newspapers or magazines for articles on food additives that are particularly controversial. All articles should be kept in a class file. Students can also be assigned research projects on various controversial food additives. Interested students might stage a debate on the topic of food additives.

Some "fast-food" chains publish and distribute, free of charge, booklets with nutritional information for their products. These booklets, as well as materials from the Council on Nutrition, *Prevention* magazine, and resources from home economics instructors, are potential sources for further research into American eating habits.

Students might investigate food irradiation, which is now being used to fight some food-borne diseases. The practice is controversial among consumers, however. Students could stage a debate or a panel discussion on the issue.

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FOOD ADDITIVES

Reading the label on a food product may make you wonder how much of what you eat is really food. Ingredients with names like xantham gum, soy lecithin, BHA, and BHT may sound strangely unappetizing and raise questions in your mind. Why do we have so many additives in our food? Are any of these additives harmful? How are we protected against harmful additives? In the sections that follow, you will find some answers to these questions.

Why Do We Have Additives in Our Food?

People have been adding substances to their food for thousands of years. The first additives were preservatives, substances that kept food from spoiling. Many things we now think of as spices were first used to prevent spoilage. Their flavors also hid the taste of rotten meat and eventually became valued for their own sake. Thus, flavoring was another early reason for additives.

Today, food processors use additives for these reasons and many others.

To Prevent Spoilage. Spoiled food is food whose chemical composition has been changed by the action of enzymes. Enzymes in food cause chemical reactions that create products that make food unpleasant or unsafe to eat. Microorganisms in food produce their own enzymes to use the nutrients from the food that they need. For example, in some foods microorganisms break down proteins into ammonia and suphurous compounds—creating the noxious "rotten egg" smell that some foods give off.

Spoilage can be slowed or stopped by subjecting food to severe heat treatments, by refrigerating food, by drying or dehydrating food, and by use of chemical additives. Some examples of chemical additives used to prevent spoilage are propionic acid, sorbic acid, benzoic acid, and salt, which retard mold growth on cheese and bread; sodium nitrite prevents growth of *clostridium botulinum* in meat. BHA and BHT prevent fats from becoming rancid by reacting with free radicals to prevent oxidation.

To Enhance Flavor. Everyone wants their food to taste good. Salt and a wide variety of spices enhance flavor. Monosodium glutamate, commonly known as MSG, is another common flavor-enhancer.

To Sweeten Food. Sweetening food is closely related to adding spices in that the purpose is to make food taste better to people. Of course, the most common sweeteners are sugars (sucrose, dextrin, fructose), but many artificial sweeteners are also added to food. These include saccharin, asparatame, sorbitol, and mannitol. New sweeteners, particularly low-calorie options, are constantly being researched.

To Add Nutrients. Did you start your day with calcium-fortified orange juice, bread made with enriched flour, and milk with Vitamin D added? If you did, you are well aware that some additives are used to make food more nutritious. Often, these additives are vitamins and minerals. Iodine added to salt is another example. Researchers soon hope to be able to add "fluffy cellulose" to products to give them more fiber without giving them the coarse or gritty texture of natural fiber.

To Make Food an Appealing Color. How foods look affects how we feel about eating them. Consequently, companies add coloring agents to enhance foods' visual appeal. Carotene—a natural yellow color—is added to butter and margerine. Various dyes are added to many other foods to give them an appealing appearance. Bleaches such as SO_2 are used to whiten foods such as flour and cheese. The bleach also disinfects and preserves dried foods and speeds the maturing of cheese.

To Give Foods an Appealing Texture. Leavening agents such as baking powder and baking soda produce CO_2, which expands as food cooks, giving food a light texture. Emsulfiers, such as cellulose gums and dextrins, give foods a smooth texture and stabilize oil-water mixtures such as mayonnaise, thus preventing them from separating. Humectants such as glycerin help foods retain their moisture, while anticaking agents such as sodium ferrocyanide prevent salt from clumping.

Are Any Additives Harmful?

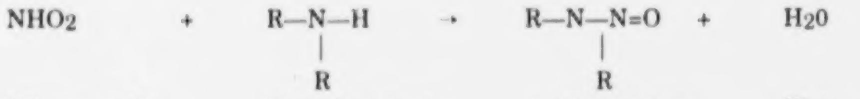
While the government tries to protect people from harmful food additives, they may not always be successful. For example, in the 1960s a popular artificial sweetener that had been on the market for a number of years, cyclamate, was banned when tests indicated that ingesting it caused cancer in lab animals. In the 1980s, however, the manufacturer of cyclamate attempted to get permission to reintroduce the sweetener to the market, claiming that the research was flawed.

A high sodium level is associated with health problems such as high blood pressure. Thus, use of salt (NaCl) can be harmful; many canned and frozen foods have high salt levels. Similarly, sugar can promote tooth decay, contribute to weight problems, and pose serious dangers to diabetics. These substances are not technically considered additives, however, since they are on a list that is exempted from regulation. Called the "Generally Recognized as Safe" (GRAS) list, this list also includes vinegar, vitamins, and some minerals.

A current controversy relates to nitrites. Sodium nitrite ($NaNO_2$) is used to prevent spoilage in meats; it also enhances color. It is common in cold cuts, sausages, frankfurters, and bacon. The problem with nitrites occurs in the stomach, where they come into contact with hydrochloric acid (HCl). The nitrites are converted to nitrous acid (HNO_2).

$NaNo_2$	+	HCl	→	HNO_2	+	NaCl
Sodium nitrite		Hydrochloric acid		Nitrous acid		Sodium chloride

When proteins are broken down during digestion, they create what are called secondary amines, nitrogen compounds that have two carbon groups attached. These groups are denoted by the letter R. Nitrous acid can react with these secondary amines to create nitrosamines, a carcinogen.



$$NHO_2 + \begin{array}{c} R-N-H \\ | \\ R \end{array} \rightarrow \begin{array}{c} R-N-N{=}O \\ | \\ R \end{array} + H_20$$

Nitrous acid	Secondary amine	A nitrosamine	Water

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How Are We Protected Against Harmful Additives?

Concern about the safety of our food dates back over 100 years. One of the first people concerned about food safety was Dr. Harvey Washington Wiley, chief chemist of the U.S. Department of Agriculture from 1883 until 1912. When Upton Sinclair published his novel about the meatpacking industry, *The Jungle*, in 1906, the fight for regulation of food producers received a tremendous boost. Congress passed both the Meat Inspection Act and the Pure Food and Drug Act in 1906, the first laws authorizing the federal government to regulate the safety and quality of food. The law was to be enforced by the Bureau of Chemistry at the U.S. Department of Agriculture, the predecessor to the Food and Drug Administration.

The 1906 act was replaced by the Federal Food, Drug, and Cosmetic Act of 1938, which, among other things, required labels on processed, packaged foods to contain the name of the food, its net weight, and the name and address of the manufacturer or distributor. The law also prohibited statements in food labels that are false or misleading. A list of ingredients was also required on certain products.

The law has been amended several times. Amendments particularly related to additives include the Food Additives Amendment in 1958 and the Color Additives Amendment in 1960. The Food Additives Amendment stated that "no additive shall be deemed safe if it is found to induce cancer when ingested by man or animal." This amendment also included the GRAS list, which exempted certain additives from regulation.

Testing additives is quite expensive. The costs of testing additives are passed along to consumers through higher food prices.

In recent years, Congress has passed legislation making labeling laws stricter. In the past, food labels were required to list the ingredients in decreasing order of abundance, but some ingredients could still escape specific mention on the label. Some foods, called "standardized foods," did not have to be labeled with their ingredients. Examples of standardized foods were mayonnaise, ketchup, and peanut butter. Changes under the new laws include such requirements as:

- The listing of color additives.
- The listing of ingredients in "standardized" foods.
- The labeling of fruit and vegetable juices.
- Inclusion of nutrition information on most food labels.
- Information on the amount of fat, cholesterol, fiber, and other nutrients per serving.
- Use of such terms as "light" or "fat-free" only if they meet federal definitions.

It is hoped that the new labeling practices will allow Americans to make healthier choices when purchasing foods.

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21. GREENVILLE'S GARBAGE

Introduction:

If all the garbage in the United States was collected and put into garbage trunks that were parked bumper to bumper, the line of garbage trucks would stretch from California to Florida. This analogy suggests that the United States has a garbage problem. In some states, the problem is a monumental one. Most of the states in the northeastern United States have run out of land on which garbage can be disposed. These states are turning to such alternatives as incineration and mandatory recycling programs.

Much of the garbage generated is biodegradable; it will breakdown or decompose. Paper, wood products, cloth, and food are good examples of biodegradable materials. Other materials, such as plastics, chemicals, and some metals, are not biodegradable and will never decompose.

In this activity, students look at their own "throw-away" lifestyles and determine the amount of nonbiodegradable material they throw away in a day's time. Then then read about a hypothetical community that must decide what to do about its garbage problem. Students work in a group to discuss the alternatives and write individual reports to the city council regarding the decision to be made.

Objectives: Students will be able to:

1. Identify biodegradable and nonbiodegradable materials used during a day.

2. Explain why the United States has a garbage problem and where that problem is most severe.

3. Describe risks involved with various disposal technologies.

4. Analyze a case study and propose a solution to the problem presented in the case study.

5. Value the ability of each individual to help solve the garbage problem.

Subject/Grade Level: Earth science/grade 8; physical science/grade 9; environmental studies/grades 9-10; biology/grade 10; chemistry/grade 11; civics/grade 9; government/grade 12; current events/grades 7-12

Time Required: 2-3 class periods

Materials and Preparation: Make copies of Handouts 21-1 and 21-2 (optional) for all students. Make a set of Consultant Cards for each group of five students.

Developed by Janice V. Pearson, Northglenn, Colorado.

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Procedures:

1. Review with students the difference between biodegradable and nonbiodegradable materials. Let the students brainstorm materials that fit into the two categories.

2. Ask students to keep two lists of materials they throw away from the time they leave class until they return the next day. One list should include biodegradable materials, the other nonbiodegradable materials.

3. Write "biodegradable" and "nonbiodegradable" on the chalkboard as headings for a class list. Then ask volunteers to share their lists with the class while you post the various items on the chalkboard. Let students determine if each item is biodegradable or nonbiodegradable. Many of the items will be the same for all students, so write each item only once.

4. After a lengthy list has been developed, discuss with the class the following questions:

- How could the list of nonbiodegradable materials be reduced?
- What can you do personally to reduce nonbiodegradable waste?
- How does the amount of nonbiodegradable material thrown away create a problem for the United States?

5. Share with students the garbage truck analogy provided in the **Introduction**. Discuss reasons why the garbage problem is more acute in some parts of the United States than in others (less land is available for garbage disposal where population density is high).

6. Distribute copies of Handout 21-1 and allow time for students to read it. Review the information provided with the class.

7. Go over the steps involved in making a decision. List these on the chalkboard:

- Identify the issue.
- Determine alternative solutions.
- Weigh the costs and benefits of each alternative solution.
- Determine the most appropriate solution for the issue.

8. Divide the class into groups of five students. Give each group a set of Consultant Cards. Have students read and discuss the cards in their groups. They should then begin the decision-making process. Each group should appoint one person to take notes as the decision-making process is implemented. This person will report back to the entire class. Allow groups time to determine a proposed plan of action.

9. When all groups have completed their decision-making process, ask each group to report back to the class on the solutions they considered, which one they selected, and why they made that selection.

10. After all the groups have reported, conduct a class discussion using the following questions:

- What is the value of using this type of decision-making process to solve a problem?
- What could individuals do to help solve a local garbage problem?

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- Who should be responsible for deciding what kind of garbage disposal facility a community uses?
- How important should individual opinions be in a community decision?
- How can individuals become more involved in making decisions about environmental issues?

11. Conclude the lesson by asking each student to prepare a written report, addressed to the Greenville City Council, that will help the city council make its decision about the kind of garbage disposal facility to build.

Extension/Enrichment:

Assign students to complete Handout 21-2 as a way to begin thinking of ways that they can address the garbage problem in their own lives.

Identify environmental issues on which your local government will be taking action. Have students research these issues, discuss the alternatives that could be suggested, and come up with a proposed solution. Encourage students to write letters to the local government or newspaper expressing opinions about the issue studied.

GREENVILLE'S GARBAGE

Greenville, a city of 63,000 people, is faced with a technology dilemma. Because of the amount of garbage produced in the city, the landfill will be full within two years. After extensive research, city officials have determined that two solutions to the problem must be considered. Either the city will build another landfill next to the current landfill, or it will build an incinerator where the city's garbage can be burned.

These two options have been carefully considered by the city council. Experts have presented information for the city council to consider. Input from residents of Greenville will also be important for the city council to consider prior to making its decision. After all the citizen input has been considered, the city council will make its decision.

You are a member of a citizen's group that will send a recommendation to the council. In your group, review the information provided by the five special consultants. With your group, decide what action to recommend to the city council.

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RECYCLING WORKSHEET

1. Paper, aluminum, and glass are the three most commonly recycled resources. Which of these is most important to recycle for economic reasons? Why?

____

____

Which of these three is most important to recycle for political reasons? Why?

____

____

Which of these three is most important to recycle for environmental reasons? Why?

____

____

2. As individuals, we can conserve, reuse, or recycle materials in many different ways. For example, we can write on both sides of paper or buy beverages in returnable, reusable bottles. Identify at least five other ways that we, as individuals, can conserve, reuse, or recycle materials.

____

____

____

____

____

____

3. Describe three everyday activities you would be willing to change to reduce the problems of solid waste disposal.

____

____

____

____

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CONSULTANT CARDS

Carol Johnson, Hydrologist

As a hydrologist, I evaluate the levels of pollutants found in our groundwater. Since Greenville relies on groundwater for its drinking water, our water supply must remain uncontaminated. If a new landfill is built at the proposed site, there is a 35 percent chance that contamination will occur. Although the Environmental Protection Agency requires that all new landfills be lined with special plastic materials and that regular testing be done for leaching of hazardous chemicals into the soil and eventually the groundwater, strong evidence shows that even the best-built landfill will eventually leak, contaminating the soil and water. Testing to determine if leaking is occurring is very expensive. However, cleaning up contamination can cost as much as $50 million.

Jake Summers, Sanitation Engineer

The current landfill will be completely filled in less than two years. The proposed landfill can be built at a cost of $78,000. It will cover 10.3 acres of land. At the rate at which Greenville's garbage production is increasing, this facility should last the city about 20 years. Because of its increased capacity, the city should consider hiring an additional 25 workers to pick up, haul, and manage the solid waste at the landfill site. Every regulation will be followed to ensure that this new landfill will be safe and will not cause pollution.

Ed Winters, Environmental Consultant

I have very mixed concerns about both of the suggested waste disposal facilities. The landfill will be built adjacent to the existing facility, but the proposed area will also use part of the land that has been set aside as a wildlife preserve. This area has been a favorite for hikers, campers, and birdwatchers. The proposed landfill could endanger the wildlife. Unless the city is very careful about disposal of hazardous chemicals in this new landfill, air and water pollution could be a problem.

The proposed incineration facility could also present environmental problems. Unless adequate technology is used, dioxins—hazardous chemicals produced during incineration—would escape into the atmosphere and pose a health threat to those living in Greenville.

Maggie Henry, Construction Engineer

The incineration facility that has been proposed for Greenville will cost approximately $12.3 million and will be able to handle 450 tons of garbage per day. If all safety specifications are followed, air pollution will be minimized. Because the ash that results from the burned garbage has been classified as a hazardous waste by the EPS, it will need to be disposed of safely. The Morrison landfill has agreed to let Greenville dispose of its ash there if properly stored in sealed barrels. This will add an additional $55,000 per year in disposal costs.

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Gary Miller, City Personnel Manager

Both of the proposed facilities have economic pros and cons. I have listed those in a chart.

Landfill—

Pros: Will provide adequate garbage disposal for 20 years.
If monitored, will not cause air pollution.
Is less expensive than incineration facility.
Will employ 25 new individuals.

Cons: Has the potential to cause groundwater pollution.
Has a limited life (20 years).
Will damage part of the wildlife preserve.

Incinerator—

Pros: Can handle 450 tons of garbage per day.
Will employ 43 new workers.
Will provide some of the heat and electrical energy for the city, saving the city $35,000 per year.

Cons: Will cost an additional $55,000 per year to dispose of toxic ash.
Could be a source of air pollution, particularly dioxins, which are hazardous to health.

22. PESTICIDES: A GLOBAL PROBLEM

Introduction:

Technology has increased the level of interdependence in the world. Some technological advances have had a detrimental effect on the global environment. The use of pesticides is a good example. Many pesticides banned for use in the United States because they have been proven toxic and carcinogenic are still being manufactured and sold to other countries, particularly Third World countries. These countries use the dangerous pesticides on food crops that are then exported to other countries, including the United States. The United States depends on these countries for a large portion of its fruits and vegetables. The countries growing the crops depend on the United States and other developed nations to provide the pesticides needed to produce these food crops. Meanwhile, the pesticides and foods grown with them pose environmental and health problems both here and abroad.

This lesson introduces students to the pesticide problem. Through their examination of this issue, students learn how the nations of the world are interdependent.

Objectives: Students will be able to:

1. Identify use of pesticides as a global environmental issue.
2. Explain how this issue illustrates global interdependence.
3. Analyze arguments for and against using dangerous pesticides.
4. Recognize the value of diverse viewpoints on an issue.

Subject/Grade Level: Physical science/grade 9; biology/grade 10; environmental studies/grades 9-10; chemistry/grade 11; world geography/grade 7 or 10; economics/grade 12; current events/grades 7-12

Time Required: 1 class period

Materials and Preparation: Make copies of Handouts 22-1 and 22-2 for all students.

Procedures:

1. Have students brainstorm a list of major environmental problems that are a result of technological developments. (The students may identify such problems as air and water pollution, energy shortages, population growth, depletion of natural resources, nuclear waste disposal, nuclear weapons, etc.) List the problems on the chalkboard.

2. Ask students how many of the problems are global—affect all nations. How does the fact that nations share problems illustrate interdependence?

Developed by Janice V. Pearson, Northglenn, Colorado.

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3. Distribute copies of Handout 22-1 and have volunteers read this information aloud. Ask the students:

- What environmental problems are evident in this article?
- What technological problems are evident in this article?
- How serious do you consider this problem?
- Who is most seriously affected by this problem?
- What is the major effect of this problem on the people of the world?

4. Give each student a copy of Handout 22-2. Students should complete this worksheet before discussion is continued. The worksheet allows students to look at both sides of the pesticide issue.

5. Summarize the activity with the following questions:

- In what way does this issue illustrate global interdependence?
- Can you think of other ways in which nations are interdependent?
- Who is responsible for solving global environmental problems such as the problem with pesticides?
- How can you help solve global environmental problems?

Extension/Enrichment:

Students may conduct research in their local community to answer two questions: (1) what pesticides are used or sold in our community? and (2) what foods available in our community are imported from Third World or developing countries? Students may simply answer these questions or may delve further into each, looking at what ingredients are used in the pesticides sold locally, what the health and environmental effects of these pesticides are, which foods available locally were grown in countries that use banned pesticides, how grocery importers work with the Food and Drug Administration, and so on.

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THE PESTICIDE PROBLEM

Pesticides are chemicals that control or kill pests—insects, weeds, and diseases—that destroy crops or spread diseases to humans. Pesticides are a technology—a method people have developed for achieving a practical purpose. The three categories of pesticides are described below:

1. Insecticides kill insects by affecting respiration, digestion, or the nervous system. Some insecticides are sprayed on the soil; they are then taken in by the plant through its roots. When an insect eats the plant, it is poisoned. Other insecticides are sprayed directly on the plant; insects are killed either by eating the plant or by taking in the poison through their skin.

2. Herbicides are used to kill weeds. They too can be sprayed on the soil or directly on the weeds. Some herbicides damage the weed's structure, while others make it impossible for the weed to grow or to use energy from the sun. Some herbicides are selective (i.e., they kill only certain types of plants); others are nonselective (i.e., they kill many kinds of plants) and thus can actually damage the plants they are supposed to protect.

3. Fungicides usually kill by direct contact with the organisms that cause plant diseases. They are sprayed or dusted directly onto the crops.

Because of a range of serious environmental and health effects, the Environmental Protection Agency has banned or severely restricted use of a number of pesticides in the United States. Table 1 lists five such pesticides, identifying their status in the United States and the health and environmental effects they cause. These pesticides can, however, be manufactured by U.S. firms and sold to other nations. The largest market for these pesticides is in developing nations. Dangerous pesticides are purchased in developing nations because they allow growers to increase production, particularly of unblemished produce for export.

Continued manufacture and sale of these extremely toxic pesticides pose health problems for at least four groups: (1) workers who manufacture and transport the pesticides, (2) users in Third World countries, (3) people living near where the pesticides are used in Third World countries, and (4) those who eat the food grown using pesticides.

The problems are made worse in the developing nations using the pesticides because many of the users do not read English; yet the cautions and instructions regarding use of the pesticides are printed in English. In addition, most workers do not have the protective equipment needed to use the pesticides safely. Training in safe use is rarely available.

Residues are the reason that pesticides cause health hazards for those who eat food grown using the chemicals. Residue is the amount of pesticide that is in food when it is sold to be eaten. Figure 1 shows the percent of various fruits and vegetables that were found to contain residues of one or more pesticides in tests conducted in 1990-1992. To protect people from eating foods with dangerous levels of pesticides, many governments set tolerances. A tolerance is the level of pesticide considered safe in food. The EPA sets tolerances for foods consumed in the United States. The Food and Drug Administration tests foods to see how much pesticide residue they contain. However, the FDA is able to test only a few of the many shipments of imported food. The FDA tests do not find all of the pesticides that may be used. Consequently, many foods with residue levels above the established tolerances are believed to be eaten in the United States each year.

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Table 1

Pesticide	Level of Toxicity	Status in the U.S.	Human Health Effects	Environmental Effects
Aldrin, Dieldrin, Endrin	Extremely	Very Restricted	Cancer, brain, and nerve damage; problems with reproduction	Builds up in the environment; kills birds, fish, and animals
HCH/Lindane	Very	Banned	Cancer, problems in reproduction, liver and kidney damage, blood problems	Builds up in the environment, stays in the environment a long time, kills fish, contaminates water supplies
Paraquat	Very	Very Restricted	Lung damage	Kills fish and other small animals
Parathion	Extremely	Very Restricted	Possible cancer, problems in reproduction	Kills birds, bees, and other small animals
Pentachlorophenyl (PCP)	Extremely	Banned	Cancer, birth defects, nerve damage, liver damage, skin problems	Kills fish and other water animals, builds up in the environment

Definitions:

- "Extremely toxic" means that swallowing about a teaspoon of this pesticide will kill an average adult.
- "Very toxic" means that about two tablespoons of pesticide will kill an average adult.
- "Very restricted" means that the pesticide can only be used in certain ways. Protective clothing, gloves, respirators, and other safety measures must be used when applying these pesticides.
- "Banned" means that the pesticide cannot be used in this country.

In 1985, the Food and Agriculture Organization of the United Nations agreed to an international Code of Conduct on the Distribution and Use of Pesticides. This code presents standards to be followed in selling and using pesticides. Here are some of the code's main points:

- Governments of industrialized countries should give technical information about pesticides to governments of developing countries.
- Each pesticide should be tested to see how dangerous it is. Test results should be sent to every country using that pesticide.
- All countries should pass laws to control pesticide use.

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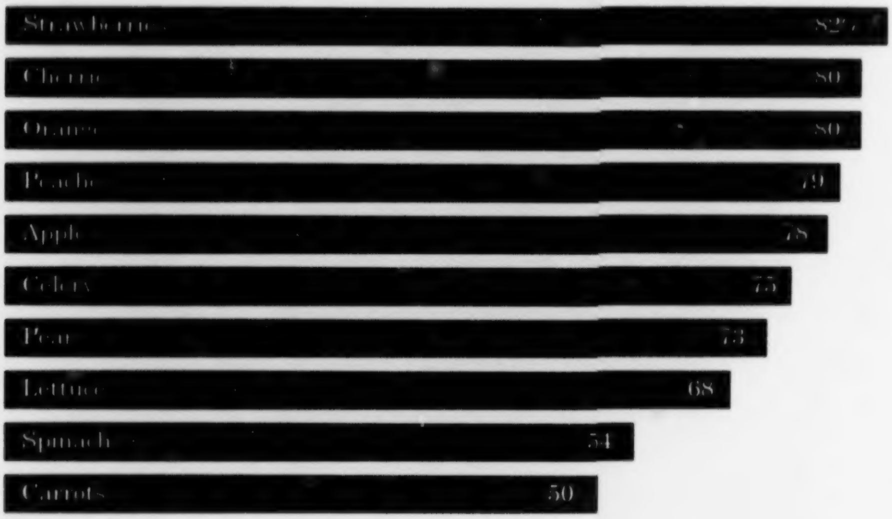
Figure 1

Percent of Samples Containing Pesticide Residue



Source: Environmental Protection Agency.

- Industrialized countries should not export pesticides they have banned.
- Industrialized countries should help train people in the developing countries how to use pesticides correctly and how to treat cases of pesticide poisoning.

All countries in the United Nations have been asked to follow this code, but there is no punishment for a country that does not follow it. There is some evidence that the code is having an effect. During a major locust outbreak in Africa in 1988, Western nations refused to provide dieldrin to combat the locusts because they feared it would end up in the food supply.

The U.S. government in 1993 announced that the EPA, FDA, and Agriculture Department would work together to reduce the use of pesticides and encourage the development of safe pesticides. One way of reducing the use of pesticides is a system called “integrated pest management.” In this method, beneficial insects and crop rotation are used to control the effects of pests. However, not everyone believes these safer methods will work. Some insects are already becoming resistant to one natural toxin that scientists hoped could replace chemical pesticides.

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PESTICIDE USE WORKSHEET

1. List ways in which the use of pesticides is a problem.

   A. ______________________________

   B. ______________________________

   C. ______________________________

   Describe how these problems illustrate global interdependence.

   ____

   ____

   ____

   ____

   ____

   ____

2. List ways in which the use of pesticides creates benefits.

   A. ______________________________

   B. ______________________________

   C. ______________________________

   Describe how these benefits illustrate global interdependence.

   ____

   ____

   ____

   ____

   ____

   ____

3. Can global problems be solved by the action of one country? Why or why not?

   ____

   ____

   ____

   ____

   ____

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23. DESIGNING SUSTAINABLE TECHNOLOGIES

Introduction:

Most physical science courses involve the study of simple machines, a unit with many practical applications that students do not immediately see. This lesson combines a technology-designing activity building on what students have learned about simple machines with a concern for creating technologies that are sustainable (that is, that do not harm the environment).

Objectives: Students will be able to:

1. Suggest and apply criteria for evaluating technologies.

2. Give examples of technologies that are sustainable (that is, that do not harm the environment).

3. Design a sustainable technology to solve a problem in their own environment.

Subject/Grade Level: Physical science/grade 9; physics/grade 12; world geography/grade 10

Time Required: 2-3 class periods (more time will be required if students actually create their technologies)

Materials and Preparation: Make copies of Handout 23-1 for all students. Before the class period in which you will begin the lesson, create a table-top display of several technologies, ranging from simple (e.g., a diaper pin) to complex (e.g., a graphing calculator). Students will also need drawing materials.

Procedures:

1. Draw students' attention to the technologies you have displayed in the classroom. Point out that all the technologies represent a human adaptation—a solution to a problem faced by people.

2. Ask students how they would evaluate whether each technology was a good solution to the problem. Post their answers on the chalkboard. Some possible answers include whether the technology actually succeeds in solving the problem and, if so, how efficiently it does so; the technology's durability; its cost; the availability of the materials from which the technology is made; the aesthetics of the technology; the technology's safety; and whether the technology damages the environment. Let students discuss their evaluations of the technologies you displayed using the criteria they generated.

3. If students mentioned potential harm to the environment, focus their attention on this criterion; if they did not mention it, add it to the list and invite student comments. Tell students that with the environmental problems we currently face, many people feel this is a very important criterion for evaluating technologies.

Based on a lesson suggested by Janice Lane, St. Louis Park (MN) High School.

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4. Distribute Handout 23-1 and allow time for students to read it. Clarify with them what the author means by *sustainability*. Discuss with them how they would evaluate the technologies described in the article in terms of sustainability and the list of criteria the class generated in step 2 above. What other technologies do students think meet the sustainability criterion?

5. Review with students the simple machines they have studied, which serve as the starting point for many basic technologies. Organize the students into groups of three. Each group is to design a sustainable technology that solves a real problem faced by group members. Each technology should incorporate at least one simple machine. Allow at least one class period for students to choose problems to address and to design their technologies. If time allows, you might have students actually build their creations.

6. As a closing activity, ask each student to choose a design created by another group and evaluate it using sustainability and the other criteria developed by the class. Each student's evaluation should be summarized in a letter to the designers.

Extension/Enrichment:

Have students create lists of the "Seven Sustainable Wonders of a Teenager's World." Create a bulletin board display of the technologies selected by the greatest number of students.

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THE SEVEN SUSTAINABLE WONDERS OF THE WORLD

When you hear about the "Seven Wonders of the World," what do you think of? Alan Thein Durning claims that he finds the seven most remarkable things in the world "as close as the backyard and your dresser drawer." His criterion for inclusion in a list of "The Seven Sustainable Wonders of the World" is that the items work without hurting the world.

In an article that appeared in the March/April 1994 *Utne Reader*, Durning nominated the following items for his list of wonders:

- The bicycle. Durning points out that this most common form of personal transportation is "53 times more energy efficient than the typical car" and allow a person to "travel three times as far on a plateful of calories as you could walking."
- The ceiling fan. Compared to air conditioning, which uses lots of energy and endangers the ozone layer because it uses CFCs as coolants, ceiling fans are, according to Durning, "simple, durable, and repairable and take little energy to run."
- The clothesline. "It takes few materials to manufacture, is safe for kids, requires absolutely no electricity or fuel, and even gets people outdoors where they can talk to their neighbors."
- The telephone. This is the only one of Durning's choices that was invented in this century. He selected it because it is a "simple extension of the most time-tested means of human communication: speech."
- The public library. Libraries have several wonderful features in Durning's estimation. They give everyone access to information, they foster community, and they save resources by cutting down on the number of books people have individually.
- The interdepartmental envelope. This is a manila envelope that has lines on it so that it can be routed from one person to another. An early example of recycling, which Durning says puts "modern recycling to shame."
- The condom. Says Durning: "It's a remarkable little device: highly effective, inexpensive, and portable." He claims that objections to its disposability and excess packaging are "trivial considering the work the condom has to do—battling the scourge of AIDS and stabilizing the human population."

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24. ENERGY RESOURCES

Introduction:

In 1973, the U.S. and other major users of oil and gas were shocked by the OPEC decision to limit production and raise the price of oil. For the first time, Americans were made aware that oil and gas were finite fossil fuel resources and that as they became scarcer, the prices of these fuels would rise. Today, oil and gas seem to be plentiful again, and prices are stable. This has not, however, changed the fact that sooner or later, we will have to face shortages and higher prices. The supply and demand of energy resources has become a major issue in American and world society. What is the nature of the problem, and what are some short-term and long-range solutions? These are the questions students address in this lesson.

Objectives: Students will be able to:

1. Explain why the energy issue is a national and world problem.

2. Make decisions on energy types for the year 2000, for the U.S. and the world.

3. Understand some of the implications of six issues involved in the world energy supply/use problem.

4. Determine priorities for a U.S. energy policy.

Subject/Grade Level: Physical science/grade 9; environmental studies/grades 9-10; physics/grade 12; world geography/grade 10; government/grade 12; economics/grade 12; current events/grades 7-12

Time Required: 3 class periods

Materials and Preparation: Makes copies of Handouts 24-1 through 24-4 for all students

Procedures:

1. Give each student a copy of Handout 24-1, and ask them to complete this short, ten-item quiz. Tell the class this quiz is an "awareness" introduction to the issue and will not count on their unit or course grades. When all students have finished the quiz, give them the answers to the items, and see if there are any items on which a majority of the class had incorrect answers. For these questions, provide some explanations. Answer any questions students may raise.

From *Teaching About the Future: Tools, Topics, and Issues*, by John D. Haas and others (Boulder, CO: Social Science Education Consortium, 1987).

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Answers to Quiz:

1 = C
2 = C
3 = C
4 = D
5 = A
6 = B
7 = C
8 = D, C, F
9 = D
10 = C

2. Next, pass out Handout 24-2. Form the class into small groups of three or four students each, and ask the groups to make judgments as to the pattern that might prevail in the year 2000. Tell them that their two columns for the year 2000 must each add up to 65 (barrels per day). Each group should be prepared to defend their numbers and pattern. After 20 or 30 minutes, have each group present their numbers and totals and justify their pattern. Using this same handout, conduct a discussion to make sure students understand the nature of the six issues listed at the bottom of the page.

3. Distribute copies of Handout 24-3. As springboards for discussion, pose the following questions relating to the information regarding the United States:

- How do you explain the differences in types of energy used in 1850 and 1900?
- Why did the use of oil increase so dramatically from 1900 to 1980?
- Why did the use of coal decrease between 1900 and 1980?
- What energy sources should be dominant in the year 2000?

4. Next, have each student, based on his or her preferences, fill in the blanks for "2000," making sure that the column adds up to 100 percent. When they have finished their allocations, choose a few to read off their numbers and explain their decisions.

5. Direct students' attention to the information on the world at the bottom of this same handout. Explain that most of the developing world cannot afford oil and natural gas, and thus these nations rely on wood and coal. Now have each student fill in the blanks for the year 2000, again making sure the column adds up to 100 percent. Ask for volunteers to read and justify their allocations.

6. Pass out or place on the chalkboard the list in Handout 24-4. Explain the nature of each policy. Then ask the students to rank the policy options in two ways: (1) according to which they think are preferable and (2) according to which they think are probable (i.e., feasible). Have them use the matrix at the bottom of the handout or place it on the chalkboard for them to copy. When all students have completed their matrices, determine the class average rankings for first, second, and third places under the two categories of "Preferable" and "Probable." Discuss the results, focusing especially on differences between the rankings in the two categories.

Extension/Enrichment:

To further explore changes in energy use, students might create an energy use survey and administer it to older residents of your community (70 years or older). Questions could pursue the main energy sources for home heat and lighting, the main source of energy for public and private transportation, and the impact of changes in energy sources on lifestyles. Students could tabulate their results and discuss changes in energy use over time based on their survey.

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ENERGY QUIZ

1. How much more energy do you use than someone living in America 100 years ago?

_____A. Twice as much
_____B. Three times as much
_____C. Four times as much
_____D. Five times as much

2. Which nation in the world uses the most energy?

_____A. Germany
_____B. Japan
_____C. United States
_____D. Russia

3. The major source of the energy we in the United States use is:

_____A. Coal
_____B. Natural Gas
_____C. Oil
_____D. Wind

4. How much more energy does the United States use than a developing nation?

_____A. Twice as much
_____B. Three times as much
_____C. Five times as much
_____D. Ten to 100 times as much

5. The majority of the oil used in the United States is to:

_____A. Power our automobiles
_____B. Heat our homes
_____C. Heat and cool offices
_____D. Run manufacturing plants

6. The United States is:

_____A. A major exporter of oil
_____B. A major importer of oil
_____C. Self-sufficient in oil
_____D. Oil-rich and coal-poor

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7. A conservative estimate is that all fossil fuels will be used up by _____ years from now.

_____A. 50
_____B. 100
_____C. 500
_____D. 1,000

8. At some point in the future, the U.S. will have to rely completely on renewable energy sources. Which of the following energy sources are renewable?

_____A. Oil
_____B. Sun/Solar
_____C. Water/tides
_____D. Coal
_____E. Natural gas
_____F. Wind

9. The three nations with the largest reserves of coal are:

_____A. Saudi Arabia, Indonesia, and India
_____B. Mexico, Brazil, and South Africa
_____C. France, Egypt, and Canada
_____D. China, United States, and Russia

10. Which one of the following nations is a net exporter (sells more than they use) of oil?

_____A. United Kingdom
_____B. Japan
_____C. Russia
_____D. Germany

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U.S. ENERGY SUPPLY AND ENERGY ISSUES

(Millions of Barrels Per Day or Equivalent)

	1975		**1990**		**2000**	
DOMESTIC SUPPLY	28		36		??	
Oil		10		10		??
Natural Gas		9		9		??
Coal		7		12		??
Nuclear		1		3		??
Solar and Hydroelectric		1		2		??
IMPORTED SUPPLY	9		15		??	
Oil		9		14		??
Natural Gas		0		1		??
CONSERVATION	0		3	3	??	
TOTAL SUPPLY/USE/NEED	37	37	54	54	65	65

* *

Energy Issues

1. Expanding use versus dwindling supply
2. Renewable sources versus nonrenewable sources
3. Relative scarcity versus rising/falling price
4. Expanding uses versus conservation
5. Uses versus social costs (e.g., pollution, wastes)
6. Lifestyles 1975 versus lifestyles 2000

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SOURCES OF ENERGY USED: UNITED STATES AND WORLD

1850		1900		1950		1980		2000	
Coal	9%	Coal	73%	Coal	38%	Coal	19%	Coal	____
Wood	91%	Wood	18%	Wood	0%	Oil	49%	Oil	____
		Oil, Natural		Oil, Natural	57%	Gas	26%	Gas	____
		Gas and		Gas and		Hydro	3%	Hydro	____
		Hydropower	9%	Hydropower	5%	Nuclear	3%	Nuclear	____
								Wood	____
								Solar	____
								Conservation	____
	100%		100%		100%		100%		100%

* *

World

1980		2000	
Wood	20%	Wood	____
Coal	28%	Coal	____
Gas	15%	Gas	____
Oil	35%	Oil	____
Hydro	2%	Hydro	____
		Nuclear	____
		Solar	____
		Conservation	____
	100%		100%

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U.S. ENERGY POLICY

Suggestions for U.S. Energy Policy

1. Make utility (gas, oil, electricity) prices reflect real costs.
2. Develop alternative energy sources and uses, and create demonstration projects (solar homes, windmills, electric cars, nuclear fusion, etc.).
3. Increase the limits and costs of pollution to industry and to consumers.
4. Rely more on coal than oil and gas.
5. Require more built-in conservation in new houses, factories, and appliances.
6. Increase conservation education efforts.

* * *

Ranking the Six Policy Options

Rank	Preferable	Probable
1st		
2nd		
3rd		
4th		
5th		
6th		

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25. WHAT IF...?

Introduction:

Concepts that students encounter in physics profoundly influence their everyday lives and their view of the world, but they often have difficulty making those connections. This lesson employs a teaching strategy designed to challenge students' concepts of reality and give them a fresh perspective on the world around them. In this process, they also make connections between physics and technology, the social sciences, and earth science. The strategy involves use of "what if" questions and is introduced with excerpts from a work of literature.

Objectives: Students will be able to:

1. Describe how our conception of time affects the way we view the world.
2. Suggest possible consequences of changes in the natural world.

Subject/Grade Level: Physics/grade 12

Time Required: 3 class periods

Materials and Preparation: You will need at least one copy of Alan Lightman's novel, *Einstein's Dreams* (New York: Pantheon, 1993); four copies would be ideal. You may find it helpful to work with a literature teacher in presenting the novel to your class. You will also need to make copies of Handout 25-1 for all students. Student groups will need posting paper and markers.

The "What if" questions provided in the **Procedures** section relate to motion. If you wish to ask questions about another concept, you will need to develop additional questions. Whatever questions you use, it is important to think through each of them before assigning them to students. Student presentations are likely to bring up unexpected issues; the more thoroughly you have thought about the questions yourself, the more prepared you will be to help students work through these issues.

Procedures:

1. Begin the lesson by reading aloud the "Prologue" to *Einstein's Dreams*. When you have finished, ask students to speculate on who the young man in the story is. If they cannot guess, show them the title of the book; be sure they understand that the book is fiction. How do they react to the novelist's suggestion that dreams played a part in Einstein's scientific work? Point out that some scientists have recently begun to write about the role that intuition and insight play in advancing their work.

Lesson introduction and material on "what if" questions adapted from Fred C. Vincent, "What If...? Questions that Stimulate Classroom Discussion." Reprinted with permission from NSTA Publications, January 1993, *The Science Teacher,* National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201-3000.

2. Let students briefly speculate on what dreams of different conceptions of time might be like. If we saw time differently, how would our view of the world change? How would our lives change? Do not discuss these questions thoroughly; simply allow enough time for students to begin thinking about these issues.

3. Divide the class into four groups, assigning each group one of the dreams described in Lightman's book. Although you may want to select your own favorites, the dreams for 14 April, 26 April, 3 May, and 22 May would provide interesting contrasts. Ask each group to read its dream and discuss how the conception of time in the dream affected people's everyday lives. Ask each group to create a visual that illustrates the conception of time in their dream for the rest of the class. Allow about 20 minutes for this activity.

4. Have the groups post their visuals and allow time for discussion of how the different conceptions of time changed everyday life. If our view of the nature of time changed, how would our view of the world change?

5. Tell students that Lightman, in writing his book, may have started by asking himself "What if...?" Students are going to be asking themselves that same question about some of the concepts they have studied in physics. Assign each of the four groups from the previous phase of the activity one question. The following questions all relate to motion; you may wish to develop your own questions on another concept.

- What would happen if you were dropped down a hole that passed through the center of the earth to the other side?
- What would happen if the earth slowly stopped rotating on its axis over a period of a year? What would happen in terms of science and society? What could be done about it?
- What would happen if the earth was not tilted at an angle in reference to the sun? How would this affect weather, climate, agriculture, and society in general?
- Over a period of 100 years the earth went into Venus's orbit around the sun. How would this affect weather, climate, agriculture, and society in general? What could be done about it?

6. Give students copies of Handout 25-1 and tell them to follow the instructions in dealing with the questions. While students are working, move from group to group, offering suggestions as needed. Try to avoid giving direct or definitive answers to their questions; instead, encourage them to think creatively.

7. Allow time for the group presentations. Be aware that the presentations and follow-up discussion may reveal their misconceptions about the earth and its relationship to the sun. These misconceptions should be confronted with challenging evidence as you work with the groups.

8. Provide students time to reflect on this experience in a journal-style entry. Since thinking about the kinds of questions posed in this lesson is likely to be a new experience, reflecting on what they gained from the experience will be valuable for students.

Extension/Enrichment:

Students may want to follow up on their what if questions by further researching and writing about the issues. Students might also create their own what if questions about other concepts they have studied in physics.

WHAT IF...?

1. Before class tomorrow, answer in writing the "what if" question assigned to your group. Use your imagination and think creatively!

2. In class, work with your group. Each group should have a leader, recorder, and presenter. Brainstorm ideas on your assigned question, analyze the ideas for validity, and reach a consensus as to what could happen. Remember: this is a cooperative learning activity and proper respect for others' opinions is required.

3. Prepare a five-minute presentation to the class. Be ready to answer questions and respond to comments.

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26. WHAT SCIENCE SHOULD BE DONE... AND WHO DECIDES?

Introduction:

This lesson focuses on the questions that arise when funders decide what scientific research to support, looking particularly at how society can determine the contribution of basic research, which may not have immediate applications, to the common good. The lesson uses a case study related to physics research but could be adapted to other disciplines by using a different case.

Objectives: Students will be able to:

1. Define *basic* and *applied research*.

2. Explain the differing opinions with respect to whether basic or applied research should be supported with public funding.

3. Develop a test or policy for determining whether research contributes to the public good.

4. Apply the test to a case study.

Subject/Grade Level: Physics/grade 12 (with adapted case, any high school science course); government/grade 12; current events/grades 10-12

Time Required: 2 class periods

Materials and Preparation: Make copies of Handouts 26-1 and 26-2.

Procedures:

1. Ask students to imagine that they are on the board of a private foundation that has $1 million to support a scientific research program. Your foundation's purpose is very general—to benefit the common good. The board received many outstanding proposals, but they have narrowed their selections to two. One proposal is for a study of fossils in a particular geographic region; the scientists proposing the study hope to advance human knowledge of the history of life on our planet. The second proposal is for an experimental study of a treatment for a particular disease that affects young children. Ask students to free write for three minutes on which study they would be most likely to fund and why.

2. After the free-writing period, conduct a discussion of students' responses. How many would fund the paleontology study? How many would fund the medical study? What are their reasons? If students cite the practical applicability of the medical study, ask them to consider the value of more knowledge about the world. How does knowledge, even if it does not have practical applications, benefit society?

Developed by Laurel R. Singleton, SSEC.

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3. Explain that most scientists today rely on funding from either government or private sources to do their work. Funders decide what science to support depending on their own priorities. For example, a drug company supports research that it hopes will result in new products it can sell. Often, there is disagreement about what priorities government agencies, such as the National Science Foundation, should have. While there is general agreement that research supported by the government should contribute to the common good, there is no consensus about what kinds of research do so, or do so most directly or most effectively. One argument is whether advancing knowledge contributes to the common good, even if the knowledge has no immediate practical application.

4. Distribute Handout 26-1 and allow time for students to read it. Divide the class into small groups to consider the questions posed in the reading. Encourage the groups to come up with tests or policy statements that could be used to determine what science should be funded. Circulate among the groups, being sure that all the groups are considering the common good in developing their test or policy.

5. Next, explain to students that they will apply their policy or test to a case study involving the superconducting supercollider, a huge particle accelerator that would help particle physicists understand the composition of matter and the origins of mass. Distribute Handout 26-2 and allow time for students to read it. In their groups, students should apply the tests or policies developed previously in determining whether to fund construction of the SSC. (Note: You may develop a case study on an issue in the news or of particular interest to your course to use in place of the SSC case study.)

6. When the groups have completed their work, have them report out to the class. How many groups decided to fund the SSC? How many decided not to fund it? What definitions of the *common good* underlay the decisions?

7. Share with students the actual information about the SSC, which Congress decided to build in 1988 and then defunded in 1993 (although $640 million were allocated to shutting the project down; this amount was more than the National Science Foundation spent on all the earth sciences and astronomy combined during the year). Discuss with students how they feel about the decision, especially about the fact that the more recent decision overruled an earlier one, resulting in what one might consider wasting of the first five years' investment in the SSC. Given the political nature of government decision-making, how could such changes be avoided?

8. Ask students whether their thinking about the initial dilemma posed in the lesson has changed. Would they still favor funding the study they voted for at the beginning of the lesson? Why or why not? If they were the scientist proposing to do the study students did not favor, how might they make a case for their study? How could it be construed as contributing to the common good? You may wish to have students write an essay related to this question.

Extension/Enrichment:

For many years, Senator William Proxmire of Wisconsin awarded Golden Fleece Awards for federally funded research projects that he felt were a waste of the taxpayers' money. Encourage students to find out about some of the studies that "won" Proxmire's award. How might the scientists conducting the research justify their work's contribution to the common good? Why did Proxmire question the funding?

THE DICKEY FLATT TEST

At the 1992 Republican National Convention, Senator Phil Gramm of Texas proposed that a new test be used to decide what programs, including scientific research, should be funded. The test was called the Dickey Flatt Test. It involved calling Dickey Flatt, a store owner in Mexica, Texas, and asking him whether the program improves his life.

While the Dickey Flatt Test was undoubtedly presented in jest, the idea behind it raises serious questions. Many political leaders think that the federal government should only fund research that has immediate applications. During the 1992 presidential campaign, both President Clinton and Vice President Gore spoke about the need to put more science research money into projects that will serve clear national goals.

Such an attitude concerns scientists who do basic research, research that is intended to advance knowledge, without thought of applications. These scientists argue that our society is based on the notion that the pursuit of knowledge is important for its own sake. They also point out that basic research often has applications farther in the future.

While some people say that basic research can be funded by private concerns, this possibility is not without problems. Industry, a major funder of research, is also concerned primarily with applications. Furthermore, industry funding may have "strings" attached. Math professor Marty Walters criticized Exxon after the *Valdez* oil spill in 1989, calling the company "eco-terrorists and saboteurs." A company representative called the University of Colorado, where Walters teaches, and threatened to pull research money provided to Walters. Walters wasn't actually receiving any funding from Exxon, but the implications are clear.

If you were a member of Congress, what type of scientific research would you choose to fund? How would you balance applied research, which might solve important problems, and basic research, which could advance our understanding of the natural world without immediate tangible benefits? Try to develop a serious test that could be used to determine whether a scientific study contributed to the public good. Also consider who should make decisions about funding—the public, their elected representatives, experts?

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SUPERCOLLIDING SUPERCONDUCTOR— YES OR NO?

For hundreds of years, scientists have tried to identify the basic building blocks of matter—the simplest structures of which matter is composed. The simplest structures that physicists have now identified are quarks and leptons. Quarks and leptons were discovered using a technology called the particle accelerator. An accelerator allows physicists to speed up protons, electrons, and other particles to speeds at which new particles were revealed. Scientists call the particles revealed by accelerators the "particle zoo" and gave particles such names as mesons, sigma particles, K particles, and J/psi particles. They believe all these particles are made up of quarks and leptons.

Many physicists think, however, that quarks and leptons may be composed of even more elementary structures. At present, researchers do not have the tools to allow them to determine whether this is true. The superconducting supercollider is a tool that many physicists think could answer the question of what the basic building block of matter truly is. The superconducting supercollider (SSC) would collide two beams of particles, both moving at incredibly high velocities, speeds that would allow new particles—if they exist—to be detected.

The SSC would cost about $6 billion to build. In part because of the high cost, the building of such a research tool is very controversial. Below are some arguments for and against building the SSC:

For building the SSC:

- This tool would help us better understand the natural world. It will answer basic questions about the nature of matter and why matter has mass.
- The knowledge gained using the SSC would have applications in the future. We simply can't identify those applications yet.
- Building and operating the SSC will provide jobs to the people of Texas, where the SSC is to be built.

Against building the SSC:

- The SSC costs too much. It will take money away from other areas of research in biology, chemistry, medical science, astronomy, and other fields of physics. These areas are just as important as particle physics.
- The SSC will not solve any practical problems. It will not cure a killer disease, help clean up the environment, or solve problems of violence or mass transportation.
- If the SSC is not built, scientists will come up with another, cheaper way to gain the same information. It will just take some time for them to do so.

If you were a member of Congress, would you vote to support the building of the SSC?

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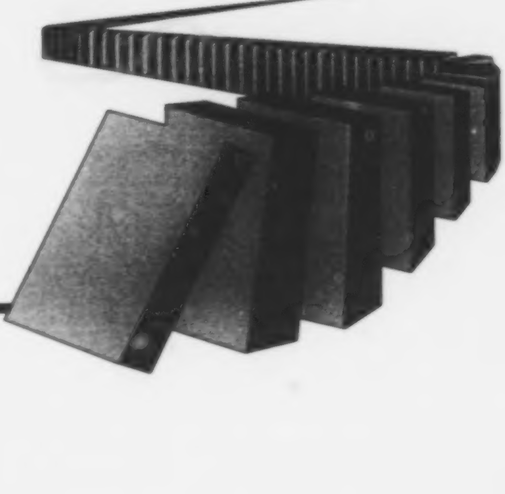
IV. STS ACTIVITIES FOR SOCIAL STUDIES CLASSES



27. A RESOURCE USE WARM-UP

Introduction:

The process of extracting resources from the earth creates a problem for people concerned about damage to the surrounding environment. This quick simulation can serve as an introduction to a unit on development and the environment by demonstrating, in a greatly simplified manner, the dilemma of competing values. It will be especially effective as an opener for a unit on resources and the environment.

Objectives: Students will be able to:

1. Explain why goals of resource extraction and environmental preservation conflict.
2. Appreciate the difficulty of resolving problems involving competing values.

Subject/Grade Level: World geography/grades 7, 10; U.S. history/grade 8; economics/grade 12; earth science/grade 8; environmental studies/grades 9-10

Time Required: 30 minutes

Materials and Preparation: You will need two chocolate chip cookies and five to seven toothpicks per student (plus a few extra cookies).

Procedures:

1. Have students move into pairs. Distribute two cookies and several toothpicks to each pair.

2. Without specific instructions, tell students to remove the chocolate chips from the cookies. Allow a few minutes for students to work.

3., Stop students and ask them to examine the results of their work. What do the chips look like? What do the remains of the cookies look like? If the chips are the most important part, and you are going to chew them up anyway, will their appearance affect the way they tasty? If the cookie is the most important part, and it is not to be consumed, but rather preserved, how does its present condition reflect that goal?

4. Students will likely protest that they were unaware of the goal of preserving the cookie. Inform them that they will have a second chance and that how well they do will determine whether the cookies will be eaten or thrown away! Students who extract the highest percentage of chips from their cookies will receive an extra cookie apiece as a reward. Have each pair of students discuss the methods they used to extract the chips the first time. How will they need to modify those efforts to preserve the cookies? What choices will they have to make? Will they be able to get all of the chips and still preserve the cookies? What is their ultimate goal? Is it worthwhile to them to leave some of the chips behind?

Developed by Robert D. LaRue, Jr., Boulder Valley (CO) Public Schools.

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5. Allow a few minutes for discussion and planning. Then distribute two more cookies to each pair. Allow several minutes for this second round of "mining."

6. Stop the "mining" and have students discuss their efforts. How did the new goal affect their methods? Their results? Did anyone choose to ignore the cookies and try to get the most chips out so they would win the extra cookie? How successful were students, in terms of mining as many chips as possible? In terms of preserving the cookies? How did they use their "tools" this time compared to the first time?

7. Ask students what this activity simulates in the "real" world. (The conflict between mining resources economically and preserving the environment.) How similar were the choices students made to choices made in the "real" world?

8. Allow students to eat the remains of the cookies.

Extension/Enrichment:

Students might research the various ways in which resources are mined. Which are most destructive to the environment? Which are least destructive? Have students create a bulletin board display showing the results of their research.

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28. WHERE HAVE ALL THE FARMERS GONE?

Introduction:

In this simulation, students examine the historical changes in the American farm, using information derived from the U.S. Census agricultural statistics for the years 1930-1980. The role of technology in creating these changes is examined.

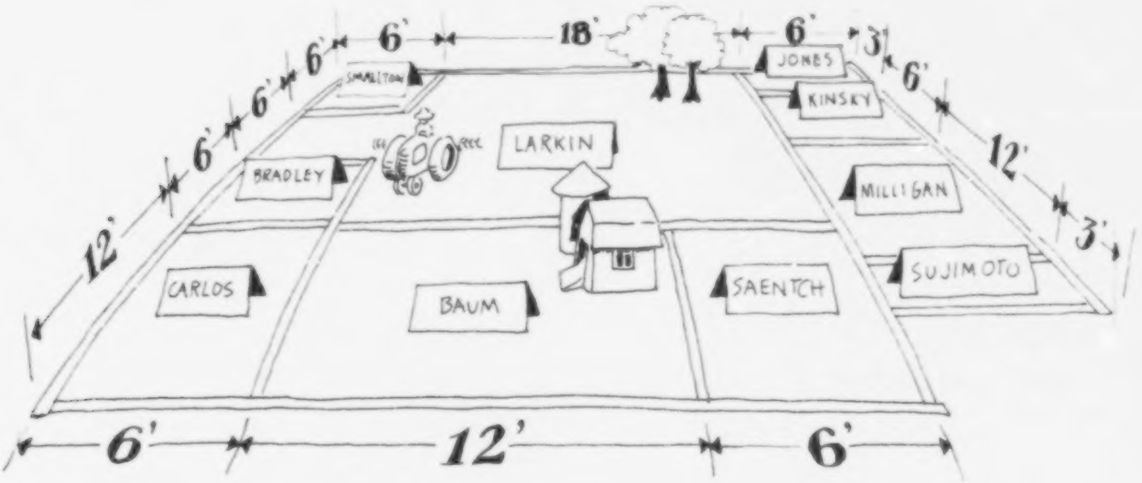
Objectives: Students will be able to:

1. Describe changes in American agriculture between 1930 and 1980.
2. Explain the decrease in number of farmers and the increase in size of farm units.
3. Recognize the relationship between new technology and changes in the family farm.

Subject/Grade Level: World geography/grade 7; U.S. history/grade 8; life science/grade 7; earth science/grade 8

Time Required: 2-3 class periods

Materials and Preparation: Make one set of the Family Information Cards provided with the lesson. On the first day of the lesson, use masking tape to mark off proportional farm sizes on the floor of the room where the simulation is to be done. Provide spaces for town and city inhabitants, too. The sample diagram below is designed for a 30' x 30' classroom, but could easily be adapted to rooms of other sizes.



Adapted from *Food First Curriculum*, by Laurie Rubin, Food First Books: Oakland, CA, 1984, pp. 41-46.

The second part of the lesson would be most successful if you could arrange for a classroom visitor who farmed in or near your community over a significant number of years. If this is not possible, gather a variety of resources on farming in your state, including books, magazines, pictures, and the like. Your state's extension service may be able to help you locate such resources.

Procedures:

1. Explain to students that they will be learning about changes in American farms that have happened over the past 50 years. Ask the students to speculate on the types of changes they think have taken place. Post their answers on the chalkboard.

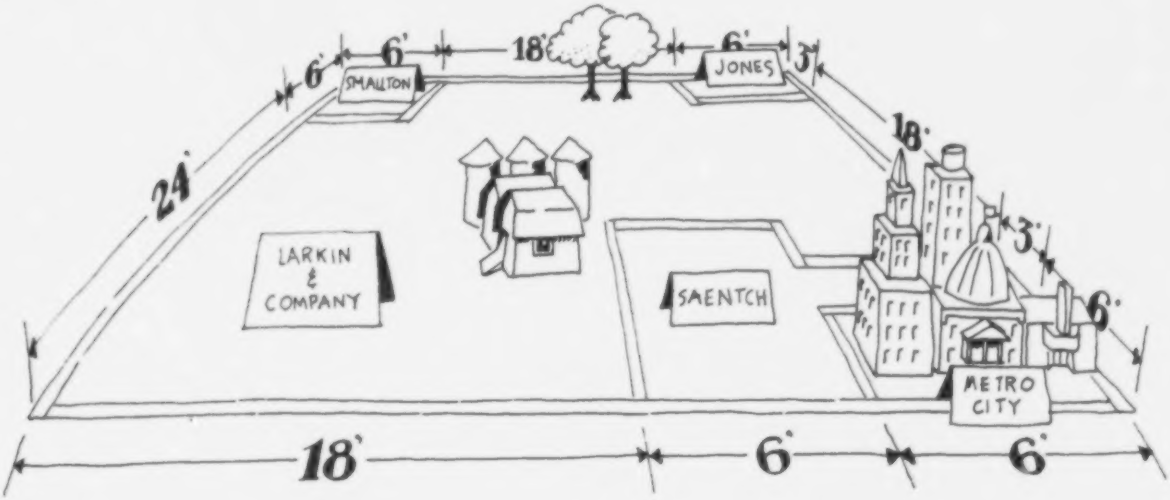
2. Divide the class into 12 groups, giving each group one of the Family Information Cards for 1930. Have each group stand or sit in the area marked-off for their farm or community.

3. Ask the students to read the information cards and to be prepared to introduce their family to the class. They should feel free to add details, such as the names of the farms or first names, ages, and personalities of family members.

4. Go around the room and have each family team introduce itself to the class.

5. Conduct a brief discussion of the life experienced by the 12 families. How much did they rely on technology? What kinds of problems did they most likely face? What were the most enjoyable parts of their lifestyles?

6. Next, adjust the masking tape floor markers to represent the new farm sizes (see sketch below).



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7. Explain that each group will now represent the descendants of the first family described. Give each group the Family Information Card for 1980 and have them move to the appropriate space. Again, allow time for them to prepare their introduction to the descendants.

8. Go around the room and have each team tell the class about its family and how life has changed since 1930.

9. Discuss the changes that occurred over the 50-year period represented in the simulation. What were the most significant changes? What role did technology play in the change process? How have the changes affected who makes decisions about farming in this country?

10. Ask students if they think farming in their own region changed in the ways they learned about in the simulation. How could they find out? What questions would they like to find answers to?

11. Explain the process you will be using to help students answer their questions about changes in farming locally (i.e., whether you will be having a classroom visitor or providing resources for student use). Conduct the classroom visit or the research. Conclude the lesson with a discussion of what students learned about changes in farming in their own region.

12. Assign students to create posters, songs, essays, or projects of their choice showing the changes in farming since 1930.

Extension/Enrichment:

Interested students could research changes in the American farm since 1980. Have the same trends continued? Why or why not? Has technology continued to change or has it stabilized? What new or futuristic technologies are likely to affect agriculture in the next 20 years?

Students could also write family descriptions predicting where the next generation of each family in the lesson will be living and how they will be earning a living.

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FAMILY INFORMATION CARDS—1930

Mr. and Mrs. Jones live with four children on a 25-acre farm. Their crops include apple trees, pear trees, raspberry bushes, and vegetables for home eating. (1930)

Mr. and Mrs. Sujimoto live with three children and two grandparents on a 25-acre farm. Crops include feed corn and vegetables for home eating. Livestock includes chickens for sale as roasters and fryers. (1930)

Mr. and Mrs. Kinsky live with two children and three grandparents on a 50-acre farms. Their crops include clover and timothy for hay or silage, oats, and vegetables for home eating. Their livestock includes dairy cattle. (1930)

Mr. and Mrs. Bradley live with one child and one grandparent on a 50-acre farm. Their crops include tomatoes for fresh market sale and vegetables for home eating. Their livestock includes chickens for egg-laying and one dairy cow for home milk drinking. (1930)

Dr. and Mrs. Schwartz live with two children and two grandparents in a house in Smallton. He is a doctor. She is a housewife. They have a small vegetable garden in their back yard. (1930)

Mr. and Mrs. Milligan live with four children on a 100-acre farm. Their crops include potatoes, beets, and carrots for sale and vegetables for home eating. (1930)

Mr. and Mrs. Saentch live with one child on a 100-acre farm. Their crops include pastureland, feed corn, oats, alfalfa for hay, and vegetables for home eating. Their livestock includes dairy cattle. (1930)

Mr. and Mrs. Carlos live with four children and three grandparents on a 100-acre farm. Their crops include peach trees, plum trees, peas and green beans for fresh market sale, and vegetables for home eating. Their livestock includes one dairy cow for home milk drinking. (1930)

Mr. and Mrs. Baum live with two children on a 200-acre farm. Their crops include pastureland, oats, feed corn, and vegetables for home eating. Their livestock includes beef cattle, sheep, and two ponies for the children to ride and care for. (1930)

Mr. and Mrs. Larkin live with five children and one grandparent on a 500-acre farm. Their crops include pastureland, alfalfa for hay, wheat, feed corn, and vegetables for home eating. Their livestock includes beef cattle. (1930)

Mr. and Mrs. Jenkins live with three children and one grandparent in a house in Smallton. He is a mechanic and manages his own gasoline service station. She is a housewife. They have a small vegetable garden in their back yard. (1930)

Mr. and Mrs. Figaretto live with four children in a house in Smallton. The family runs a small grocery store. (1930)

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FAMILY INFORMATION CARDS—1980

Mr. and Ms. Jones. He is a son of the 1930 Jones family. They live with one child on a 25-acre farm. Their crops include apple trees and peach trees and vegetables for home eating. She is a full-time high school teacher in Smallton. (1980)

Mr. Sujimoto is a son of the 1930 Sujimoto family. He moved to Metro City because he wanted the excitement of city life. He works in the electronics industry. He lives alone in an apartment and buys food in a supermarket. (1980)

Mr. and Ms. Kinsky. He is a son of the 1930 Kinsky family. They moved to a house in Smallton because they could not make enough money on the farm to support their family. They live with two children. They both work in the new food processing plant in town. They have a small vegetable garden in the backyard but buy most of their food at the new supermarket. (1980)

Ms. Bradley is a daughter of the 1930 Bradley family. She moved to an apartment in Metro City. The farm had to be sold to pay off farm debts. She lives alone. She works in a clothing store and buys her food at a neighborhood grocery store. (1980)

Mr. and Ms. Mallory. She is the daughter of the 1930 Milligan family. They live with three children in a small house near Metro City. He is an engineer; she is a housewife. The farm was sold because it was losing money. Prices for fertilizer and seeds increased greatly, but prices for the vegetables they grew did not. They have a small vegetable garden in their yard and buy the rest of their food at a supermarket.

Mr. and Ms. Saentch. He is the son of the 1930 Saentch family. They live with one child and one grandparent on a 125-acre farm that consists of the original family farm and the old Sujimoto farm, which they bought. They both work on the farm. The crops include alfalfa for hay and a vegetable garden for home eating. The livestock include dairy cattle. (1980)

Mr. and Ms. Carlos. He is a son of the 1930 Carlos family. They live with two children in Metro City in a house. He is an actor in the theater and she is a dancer. They sold the farm because prices for peaches and plums went down for a few years while prices for insecticides and the new tractor they needed went up. (1980)

Ms. Baum and Mr. Milne. She is the daughter of the 1930 Baum family. She married Mr. Milne and kept her own name. They live in an apartment in downtown Metro City. The Baums sold the farm to pay off farm debts. She is a lawyer. He is a newspaper reporter. They shop for food at a food co-op. (1980)

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Mr. and Ms. Larkin. He is a son of the 1930 Larkin family. They live with two children and two grandparents on a 1500-acre farm. The Larkins bought the old Kinsky, Bradley, Milligan, Carlos, and Baum farms. They decided that the only way to make enough money from farming for the family to live comfortably on was to have a larger farm, which would bring in more total profit. Their crops consist of wheat, corn, oats, and a vegetable garden for home eating. They have more that $1,000,000 in farm equipment. They have one dairy cow for home milk drinking. (1980).

Dr. Schwartz is the daughter of the 1930 Schwartz family. She is a medial doctor. She lives alone in a small house in Smallton. She shops for food at the new supermarket. (1980)

Mr. and Mrs. Figaretto. He is a son of the 1930 Figaretto family. They live in the same house in Smallton with three children. They both run the small grocery story. The new supermarket is giving them some trouble because of its competition, but many people still prefer to shop in a smaller place from a family they know. (1980)

Mr. and Ms. Jenkins. He is a son of the 1930 Jenkins family. They live with two children in a house in Smallton. He and one of his brothers now run the service station as partners. She is a housewife. They shop at both the Figaretto small grocery store and the new supermarket. (1980)

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29. INTRODUCTION TO THE GLOBAL ENVIRONMENT: THE BALANCE OF NATURE

Introduction:

This lesson introduces students to the interdependent nature of the global ecosystem. The discussion begins with an overview of the large systems that comprise the global environment; these include the atmosphere, oceans, land, the global water cycle, humanity's impact, and the eight major challenges to the global environment. These challenges are global warming, ozone depletion, pollution of land, water, and the atmosphere, damage from radiation, damage from wars, deforestation, and overpopulation. The student is also introduced to the concept of sustainable development, and ideas to slow the pace of change are discussed. The lesson ends with a problem-solving exercise that encourages students to offer solutions to various environmental challenges and problems.

Objectives: Students will be able to:

1. Describe and give examples of the interdependent nature of the global ecosystem.
2. Give examples of the large ecosystems that make up the global environment.
3. Explain different ways humans have altered or transformed the global environment.
4. Articulate solutions to various global environmental problems.

Subject/Grade Level: World geography/grades 7, 10; earth science/grade 8; environmental studies/grades 9-10

Time Required: 3-5 class periods

Materials and Preparation: Make copies of Handouts 29-1 and 29-2 for all students. You will also need posting paper, markers, and tape.

Procedures:

1. Begin the lesson by asking students to give examples of how the earth's environment is interdependent. Interdependent can be defined as "mutually reliant." Some examples might be the earth has only one atmosphere and we all enjoy breathing clean air, or we all suffer the effects of increased carbon dioxide emissions and the depletion of the ozone layer. Rainforests in South America and Asia release carbon into the atmosphere, which is necessary for survival of plants, animals, and humans. Destruction of rainforests diminishes the amount of carbon released into the global atmosphere and destroys plant and animal life (earth's genetic endowment), some of which could be used as medicine to fight and cure diseases.

From *Global Issues for the 90s* by Heidi Hursh and Jonathon Fore (Denver, CO: Center for Teaching International Relations, and Boulder, CO: Social Science Education Consortium, 1993).

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2. Ask students to give examples of how the global environment and global economy are interdependent. Some examples might be the use of natural resources such as oil from the Middle East, hardwoods from the forests of West Africa and Asia, South American beef, and cereal grains grown in the United States that are exported to Africa and Asia. Have students give examples of how humans have altered or transformed their local environment. Do local changes to the environment affect the larger global environment?

3. Assign the class to read Handout 29-1. You can assign specific study questions for each section of the reading. Remind students that they will be responsible for discussing the information in the handout, as well as responding to questions from the material in the handout in written form.

4. After students have read the handout, begin a discussion of its main points. Following are some discussion questions that can be used in whole- or small-group discussions and writing assignments.

- What is "Earth Systems Science" and what does this approach offer towards our understanding of the global environment?
- What are the three main systems of the global environment? How do they interact?
- Draw a diagram of the greenhouse effect. Why is it important to the global environment?
- How do we depend on water for our survival as individuals and as a planet?
- How has humanity altered the global environment?
- What has been the role of science and technology in altering the global environment?
- What are some of the serious and immediate environmental hazards with which we must deal?

5. On the basis of the reading, what do students see as the major challenges to the global environment? Post their answers on the chalkboard. Then distribute Handout 29-2 and compare the list provided there with the students' list.

6. Ask students to form groups based on the problems in which they are most interested. Each group should learn more about the problem they identified and select an action humans can take to ameliorate the problem. Each group should prepare a paper or display describing why they believe the action they selected would be most effective.

Extension/Enrichment:

Encourage students to read biographies of environmental activists or novels featuring young people involved in conservation/preservation issues. Two appropriate young adult titles are *Four Against the Odds: The Struggle to Save Our Environment*, a nonfiction book by Stephen Krensky (New York: Scholastic, 1993) and *The Weirdo*, a novel by T. Taylor (Orlando, FL: Harcourt Brace Jovanovich 1991).

INTRODUCTION TO THE GLOBAL ENVIRONMENT: THE EARTH AS A SYSTEM

The thousands of species of plants and animals that make up the global environment cannot survive in isolation. From the tiniest insect to the largest mammal, each is dependent on the other to do its part in the food chain. To eat, the mountain lion must prey on the deer, the deer must eat vegetation, vegetation needs water and nutrients from the soil to grow. All must have sunlight and air to live. This linkage of organisms into an interdependent community, or ecosystem, is the basis of nature. The complex interrelationships between plants and animals in an ecosystem is critical to its ability to function properly. Likewise, the complex interrelationships between the large ecosystems in the world like the seas and oceans, forests, agricultural lands and rivers and lakes, to name just a few, are also critical to the global environment's ability to support the 4.2 billion people on planet earth, who also require food, water, and air to live.

The following is a brief introduction to the three main systems that make up the global environment: the atmosphere, oceans, and land. This approach to the study of the earth's environment is referred to as "Earth Systems Science." Earth systems science strives to understand how the world works on a global scale by describing how its parts and their interactions evolved, how they function today, and how they may be expected to function in both the near and distant future. Earth systems science combines the natural sciences (biology, chemistry, physics, zoology, etc.), and the social sciences (economics, geography, sociology, history, etc.) in order to get a more complete understanding of how humans have altered their local and global environment.

The Atmosphere

Concerns about rainforests may seem remote to oil field workers in Siberia or to small children playing in a rice paddy in China, but the atmosphere touches us all. The atmosphere protects us against deadly radiation from space and provides us with the oxygen on which our life processes depend. It evens out what would otherwise be unlivable extremes of heat and cold and transports moisture from the oceans across continents in a never-ending global circulation system.

The atmosphere, a gaseous envelope that surrounds the earth, is the engine of the global physical climate system. When radiation from the sun enters the atmosphere, some is reflected back upward by clouds and dust, and some continues on to the land surface. Of the radiation that strikes the surface, some is absorbed by the earth, but again some is reflected back to space by ice, snow, water, and other reflective surfaces. In addition, infrared radiation is emitted by the earth. A portion of this energy gets trapped by certain atmospheric gases whose particular chemistries do not allow the outgoing, longer-wave infrared radiation to escape. Instead, this bounces back to earth, raising the surface temperature. This phenomenon, which has operated throughout earth's history, is called the greenhouse effect.

Without the atmosphere and the greenhouse effect, the earth's surface would be frozen, and life would not be possible. The composition of the atmosphere determines the earth's ability to maintain a balance between the energy coming in and energy released. The main gases in dry air are nitrogen (79 percent), oxygen (20 percent), and argon (91 percent). The main gases that contribute to the greenhouse effect are carbon dioxide, chlorofluorocarbons 11 and 12 (CFCs), methane, and nitrous oxide. These gases' concentrations in the atmosphere are rising. As they do, less radiation escapes from the surface into space, and the earth's temperature rises, a condition com-

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monly referred to as "global warming." In addition, CFCs 11 and 12 destroy the ozone layer. The ozone layer shields the earth from harmful ultraviolet radiation.

Oceans

The global ocean makes up 71 percent of the earth's surface area, and it boasts one of the world's largest living organism, the Great Barrier Reef, off the northern coast of Australia. Driven by energy from the sun, wind, and the constant, steady rotation of the earth, the ocean is constantly on the move. Surface currents like the Gulf Stream carry water from the Gulf of Mexico to northern Europe. On the other side of the globe, the Kuroshio current carries water from the Philippines to Japan, Hawaii, and the west coast of North America. Although the global ocean could be considered one large ecosystem, its plants and animals vary greatly from region to region. Water temperature, depth of water, availability of food, and saltiness all contribute to form ecosystems that vary substantially from region to region. Fish provide almost 25 percent of humanity's animal protein and over 100 million people around the world make their living from the ocean.

The global ocean is the atmosphere's partner in the physical climate system. It is an immense reservoir of heat, holding the heat it absorbs from solar radiation longer than the land does. As the ocean water moves through its grand circulation scheme, heat is transferred vertically from the surface waters to the deep ocean and back, and horizontally from high latitude to low latitude and from longitude to longitude.

As heat is released by the ocean in a region remote from where it was absorbed, it interacts with the overlying atmosphere, moderating the daily and seasonal cycles and temperature on the earth's surface areas. Thus, the global ocean helps to shape the regional features of weather and climate. The episodic phenomenon known as El Nino, a change in atmospheric circulation that occurs every two to seven years above the tropical Pacific Ocean, is the most notable example that a local disturbance in the balance between ocean and atmosphere can interact to cause an abrupt and dramatic change in the circulation of the tropical oceans and the global atmosphere.

Land

The earth's surface is a mosaic of different types of ecosystems ranging from arid desert to tropical rainforest to high alpine tundra. Each of these ecosystems supports distinct plant and animal communities, and each uniquely contributes to the functioning of the earth system.

Over days and seasons, the earth's plant communities help purify our atmosphere. Trees, bushes, grasses, flowers, etc., absorb and release carbon in a breath like rhythm. Carbon is the primary element of life. There is a limited supply of carbon and it must constantly be recycled through the global environment, largely by green plants. For instance, trees, approximately 7 percent of the land's surface area, absorb carbon dioxide, retain carbon in their wood, and release oxygen into the atmosphere. Trees also provide surface area for pollutants to settle on, which further cleans the air.

Though change is a central feature of all ecosystems, changes to the plant cover from agriculture, deforestation, and other human activities are not just another sort of gradual, evolutionary change. Rather, they significantly alter the amount of light reflected back to the atmosphere from the land, the roughness of the land surface, which influences wind patterns, and the cycling of materials like oxygen, nitrogen, and carbon through the earth system.

The Water Cycle

Without water, life would not exist on planet earth. We know it as a cool drink, a shower, a refreshing rain, a foggy morning, or a high mountain lake. Globally, water connects the various components of the biospheres, driving processes on land, sea, and air. Of the earth's water, the global ocean holds 97 percent, followed by glaciers and ice caps. Lakes, rivers, and other surface water hold a mere one or two ten-thousandths of the total global water tock.

Water evaporates from the global ocean and provides the atmosphere with most of its moisture. Evaporation and air circulation are activated by heat radiation from the sun. This evaporated water is carried over land in air masses. It then falls as rain or snow and returns to the oceans as surface or subsurface water.

On earth, water exists in all three of its physical states: ice, water, and vapor. Water is important to all living organisms because it is an effective and generally available solvent for carbon compounds. Most biochemical reactions cannot take place only in water solutions. This means that water can transport dissolved substances between different parts of the body, for example, in the blood, the serum of which is water-based. The functions of water in the organism have their equivalents outside it as well. The water we drink and wash ourselves with is a solvent, but water is also used to carry away our waste.

Humanity

Human activities have become so widespread that the effects are no longer local but are regional and even global in scale. The average city dweller in the U.S. consumes 568 liters (125 gallons) of water, 1.5 kilogram (3.3 lbs.) of food, and 7.1 kilograms (15.6 lbs.) of fossil fuels per day. The average city dweller generates about 454 liter (100 gallons) of sewage, 1.5 kilograms (3.3 lbs.) of refuse and 0.6 kilograms (1.3 lbs.) of air pollutants.

Forty years ago, 600 million people throughout the world lived in cities. In 1990 the figure was 2 billion and growing fast. At the current rate, by the year 2000, cities will have to accommodate over 75 percent of the population of South America. In Africa, 175 million live in cities, 30 percent of the total population; yet 368 million are expected to live in cities by the year 2000.

Meeting the demands of present day city dwellers is a serious strain on our local and global environment. Meeting the demands of future generations will put even more pressure on the environment. The move toward "Sustainable Development" is one answer to the unavoidable impact that the ever-increasing world population has on the earth's environment.

Sustainable Development

The World Commission on Environment and Development defines sustainable development as "development that fulfills the needs of the present without limiting the potential for meeting the needs of future generations." Sustainable development is a process in which economic, trade, energy, agricultural, and industrial policies are all designed to bring about development that is economically, socially, and ecologically sustainable. That is, current consumption cannot be financed by incurring economic debts that others must repay in the future. Sustainable development means that the natural resources of the earth should be used in ways that do not create ecological debts by overexploiting the carrying and productive capacity of the earth.

CHALLENGES TO THE GLOBAL ENVIRONMENT

The following are some of the most critical challenges to the global environment:

1. Global warming.

2. Ozone depletion.

3. Pollution of the major earth systems: air, land, and water.

4. Overpopulation.

5. Damage from wars.

6. Deforestation.

7. Transnational pollution.

8. Extinction and endangerment of plants and animals.

Some of the actions that humans might take to slow environmental damage are:

1. Improve energy efficiency.

2. Develop alternatives to nuclear and fossil fuels.

3. Price goods and services to better reflect the environmental costs of their production.

4. Make the environment a policy priority for local, national, and world leaders.

5. Restructure institutions and the decision-making process to better reflect environmental priorities.

Choose the problem or challenge in which you are most interested. Working with other students interested in that problem, find out more about the causes of the problem. Decide on an action that your group thinks would be effective in addressing the problem. As a group, prepare a paper or display that explains the causes of your problem and why you think your proposed solution would be effective. Be sure to give some attention to the role of science and technology in both creating and ameliorating your problem.

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30. THE OCEAN RESOURCES GAME

Introduction:

The basic laws of the sea were established in the 17th century and changed little until after World War II. Each nation had control of its coastal waters up to three miles from shore—the distance a cannon ball could be shot. Beyond that the seas were free for all. Improvements in military and commercial technology reopened the basic question—who owns the seas? Sophisticated fishing enterprises, aided by satellites tracking fish, overfished many regions—and raised controversies from Iceland to Peru. Depletion of the land's natural resources and the desire for independence from OPEC-controlled oil made tapping seabed oil and minerals economically and politically attractive. Pollution of the oceans—from wastes, military use, accidental and intentional oil dumping, and runoffs from land and river pollution—greatly increased. The control of the seas became, therefore, an urgent question for all nations.

The United Nations has become involved in the process of resolving the complicated questions about control of the oceans. Important conferences were held in Venezuela, Switzerland, and New York in the 1970s, culminating in the signing of a Law of the Sea Treaty in Montego Bay, Jamaica, in 1982. Although signed by 159 nations, this treaty has been ratified by only a few nations and has not gone into effect.

This lesson is a role-playing activity that provides an opportunity to explore the potentials for cooperation and conflict that have existed in relation to control of the seas. The situations the students encounter reflect some of the major issues at stake in the use of the world's seas.

Objectives: Students will be able to:

1. Identify some of the most important issues that must be resolved if all countries are to agree on a set of laws for the oceans and seas of this planet.

2. Identify the national interests of various countries, and make and defend proposals for laws of the sea that reflect the national interest of a particular country.

3. Discuss the importance and difficulty of reaching agreement on a law of the sea.

Subject/Grade Level: World geography/grade 10; government/grade 12; current events/grades 10-12; earth science/grade 8; environmental studies/grades 9-10

Time Required: 3-5 class periods

Materials and Preparation: Make copies of Handouts 30-1, 30-2, 30-3, and 30-4 for all students.

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Procedures:

1. Distribute Handout 30-1. Allow 10 minutes for students to read the handout. Discuss the boldface terms and the general issues raised in the reading. Refer students to a world map to help them better visualize the examples described.

2. Distribute Handouts 30-2 and 30-3. Have the students read the profiles of all the countries around the Sea of Plenty and acquaint themselves with the map.

3. Divide the class into six groups and assign one country to each group. Have the students meet within their "nation" to consider their objectives and how they intend to pursue these objectives in the coming international meeting.

4. Assemble the International Conference on the Sea (ICS). One student should act as chair. Suggested procedure: Each nation speaks, one student from each nation acting as the spokesperson for his/her country. This may be the chief decision-maker or another member of the delegation.

5. Have the countries meet again to determine policies and strategies based upon what happened during the conference. Then begin a negotiating period, during which countries may make bargains, agreements, or alliances with other countries in preparation for the second round of the international conference. Have countries meet individually to develop their presentations for the next meeting, and then hold the second meeting of the international conference.Continue the cycle of national meetings, negotiations, and ICS meetings until either an agreement or an impasse has been reached.

6. The following questions may be useful in a debriefing discussion:
    - What happened in the game? Were all nations able to reach their goals? If agreement was reached, was it fair to all nations?
    - How did the game compare with reality? What additional parties or pressure groups might be involved? How would their presence alter the outcome?
    - Should the mileage limits be uniform for all nations? Would that be fair?
    - What will be the consequences for the world if agreement is not reached?

7. To conclude the lesson, have students complete the following sentences:
    - The most important issue to be resolved if all nations are to agree on a set of laws for the oceans is…
    - The best thing about the role play was…
    - One thing I did not like about the role play was…

Extension/Enrichment:

Distribute Handout 30-4 and discuss the major points. How do these agreements compare to those reached during the simulation? Ask students to research the current Law of the Sea and discuss its major points. What problems have been solved? What problems still exist?

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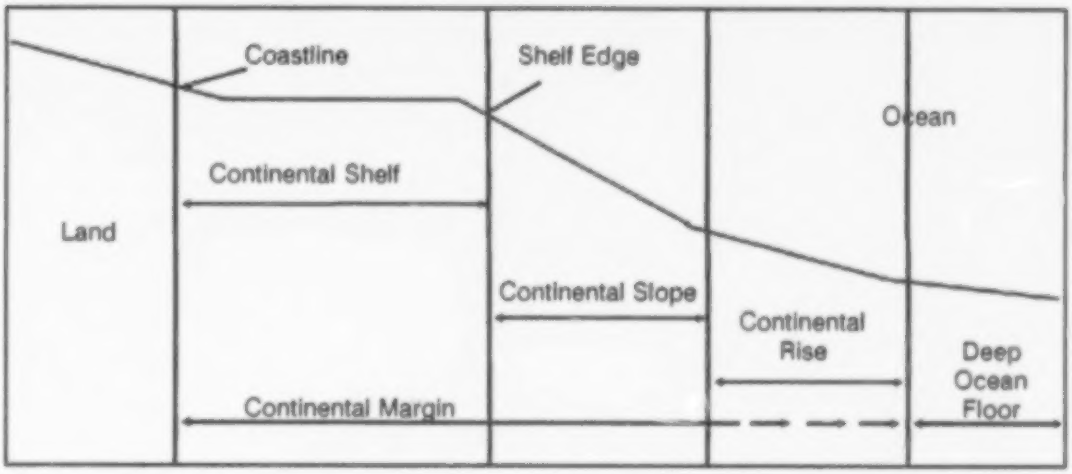
POINTS OF CONFLICT: OCEAN RESOURCES

Familiarize yourself with the diagram of the *seabed* and the ocean floor and with the data that follows. Are all parts of the ocean equally valuable? Locate the areas where the different resources are concentrated. What are some of the potential conflicts?

Diagram of the Seabed and the Ocean Floor



Data

- The **continental shelf** may be as wide as 700 miles* off Siberia, Alaska, and Argentina, and as narrow as a few miles off Peru. The average width is about 40 miles.
- The **continental margins** may have as much as 40 percent of the world reserves of oil and gas.
- Most fish are taken within 50 miles off shore, and almost all within 200 miles. The ocean supplies 13 percent of the world's animal protein consumption, but fish catches have fallen in recent years. Fishermen have successfully used sophisticated equipment to increase their catches. As a result, however, the remaining fish are insufficient in number to replenish the stock. Overfishing is believed to have contributed to the drop in the fish catch in many parts of the world.
- Lying on the sea floor, mostly beyond 200 miles off shore and the continental margins, are great quantities of **manganese nodules**. These hold a number of metals that are becoming increasingly scarce—primarily nickel (used in making stainless steel), copper, and cobalt. Harvesting these nodules from the sea may eventually be cheaper than mining them from land.

**Miles* in this handout refers to *nautical miles*. A nautical mile is 1.85 kilometers or 1.15 land miles. Nautical miles are the international standard for measuring distances at sea; for example, a ship's speed is measured in knots (nautical miles per hour).

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- At least eight private and governmental groups have already made major investments to prepare to begin ocean mining. Involved are American, Canadian, French, German, and Japanese concerns.
- With increasing shortages of food, oil, and minerals, countries are claiming more rights over the sea off their shores. A few nations, including Peru and Ecuador, claim **territorial jurisdiction** out to 200 miles of coastal seas. But other countries claim only **economic control** out to 200 miles. (This is an important difference. Economic control gives a nation the right to all the fish and mineral wealth within those limits. Territorial jurisdiction in effect extends the boundaries of a nation's property. All military, navigational, and economic rights on land would extend to this ocean territorial boundary. Economic rights would not cover military or navigational control.)
- If countries have territorial jurisdiction beyond three miles, there is a serious problem for the great naval powers, since there would be a threat to free transit through straits. If Spain were to have a 12-mile sea limit, for example, it could theoretically control the entrance to the Mediterranean Sea which, at Gibralter, is less than 10 miles wide. Under the long-standing principle of innocent passage, merchant ships can pass through straits even when they lie within the territorial jurisdiction of another nation. However, warships, submarines, and planes are not considered "innocent" and their passage could legally be blocked or restricted by the nation(s) with territorial jurisdiction over a strait. Thus, the great naval powers, such as the United States, are opposed to any extension of jurisdiction that could restrict the passage of their ships and planes through important straits.
- Some countries, like the Philippines and Indonesia, claim a 12-mile jurisdiction beyond the outermost islands of their archipelago grouping, thus enabling them to enclose huge areas of ocean within their territorial waters. Look at a map of the world—or a portion of the world such as Southeast Asia. If you shaded in a 200-mile territorial extension of each country, what situations would you see occurring?
- Many of the nations of the world believe the oceans are the common heritage of all people.
- Most of the poorest countries want an international agency to mine the mineral resources of the seabed and share the profits among nations. Burkina Fasa, Mali, Botswana, Chad, Afghanistan, and Nepal are among the poorest nations of the world. Look at a map. What do these countries have in common? How does lack of access impede the commerce and economic growth of these nations? How does this help explain their position?

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COUNTRY PROFILES

The Sea of Plenty is becoming badly polluted. Some scientists predict that living resources (fish, etc.) are diminishing and that there will be almost no edible fish and shellfish within 25 years if present trends continue. An international conference has been called by nations surrounding the Sea of Plenty to consider adopting agreements for resolving their conflicting claims to territorial limits, rights of passage, exploitation of the deep sea beyond the continental shelves, etc.

Your objective, as representatives of these nations, is to work out fair agreements on the use of the ocean's resources. The basic issues you should consider are:

- What are the special concerns of your nation?
- With which nations are you most likely to experience conflicts of interest?
- How far should a nation's jurisdiction extend?
- Should there be a national economic zone beyond the territorial limit? If so, how far?
- Do nations have the right to pollute the oceans, whether off their own shores or on the high seas? If not, what should be done about it?
- Should the ocean be considered the common heritage of the people of the world? If so, should an international organization be formed to regulate the mining of the seas and use a percentage of the profits to foster the development of poorer nations?

Read the profiles of all the countries. Your teacher will then assign you to a group representing one of the nations.

Anchovia: Per capita Gross National Product (GNP) $3,000. twelve-mile territorial limit. Now claims a 200-mile economic zone; that is, the right to all living and nonliving resources.

Insists on rights of territorial control with Bushland over the Dire Straits. Concerned about oil spills from drilling around the Sea of Plenty and from the giant tankers from Oceana. The breakup of a smaller tanker caused millions of dollars damage to beaches and wild life. Fishing, especially of anchovies, is Anchovia's major industry—and the catch is diminishing each year. It is also concerned about the depletion of salmon, which spawn up the Salmon River. Oceana's trawlers take huge catches, often within Anchovia's 1200-mile limit, which Oceana insists is legal. Anchovia demands a share of profits from exploitation of deep seabed mineral resources, and it also wants an international agency to license manganese nodule exploitation.

Bushland: Per capita GNP $700. Twelve-mile territorial limit. Two hundred-mile economic zone.

A poor, largely agricultural country. Fishing is a major source of protein for its ill-fed people. But the annual catch is declining, and this is blamed on Oceana's mass production fishing with advanced technology. Rich oil deposits have been discovered 125 miles off Bushland's southern coast. But these deposits are located on Petrolia's continental shelf. Petrolia is also drilling there for oil. Bushland wants a percentage of profits from manganese nodules, with their exploitation controlled by an international agency.

Outland: Per capital GNP $300. The country is landlocked.

Outland's people once controlled all of Petrolia and deeply resent not having any share in the great wealth coming to Petrolia from oil. Outland insists on a corridor to the sea and that all resources beyond a 12-mile limit belong to all humankind and should be placed under the jurisdiction of a worldwide organization.

Petrolia: Per capita GNP $18,000. Three-mile limit. Two hundred-mile economic zone.

Petrolia is an oil-rich country that is rapidly becoming a major industrial power. Its oil had previously been carried on Oceana's tankers, but now Petrolia is building its own naval fleet. It is insisting upon a three-mile territorial limit to insure free transit or noninterference from Bushland and Anchovia for Petrolian military vessels through the Dire Straits. Petrolia soon will have the technology to take manganese nodules from the deep seabed in the Sea of Plenty. It is therefore opposed to economic zones of 200 miles, which would prevent access to nodules within 200 miles off Anchovia, and it does not want interference from an international-controlling agency.

Oceana: Per capita GNP $20,000. Three-mile territorial limit. Twelve-mile fishing limit. Economic zone on continental shelf to depth of 200 meters.

Oceana is a highly developed industrial and military power. Its ships roam the world and fish with the most advanced technology in the Sea of Plenty, especially off Anchovia's Great Banks and Bushland's shores. Its giant tankers regularly bring vital oil from Petrolia through the Dire Straits to keep Oceana's industries rolling. It maintains a naval fleet, including nuclear submarines, in the Sea of Plenty. Free transit through the Dire Straits is essential for Oceana. It is already beginning to take manganese from the seabed at depths of two miles or more and opposes any effort to control its activities.

Lockland: Per capita GNP $500. The country is landlocked.

A poor country desperately attempting to find the capital for economic development, Lockland insists on establishing an international agency that will exploit all nonliving resources beyond the 12-mile limit, with the profits going to all nations. "Such resources are the common heritage of all mankind," declared Lockland's president.

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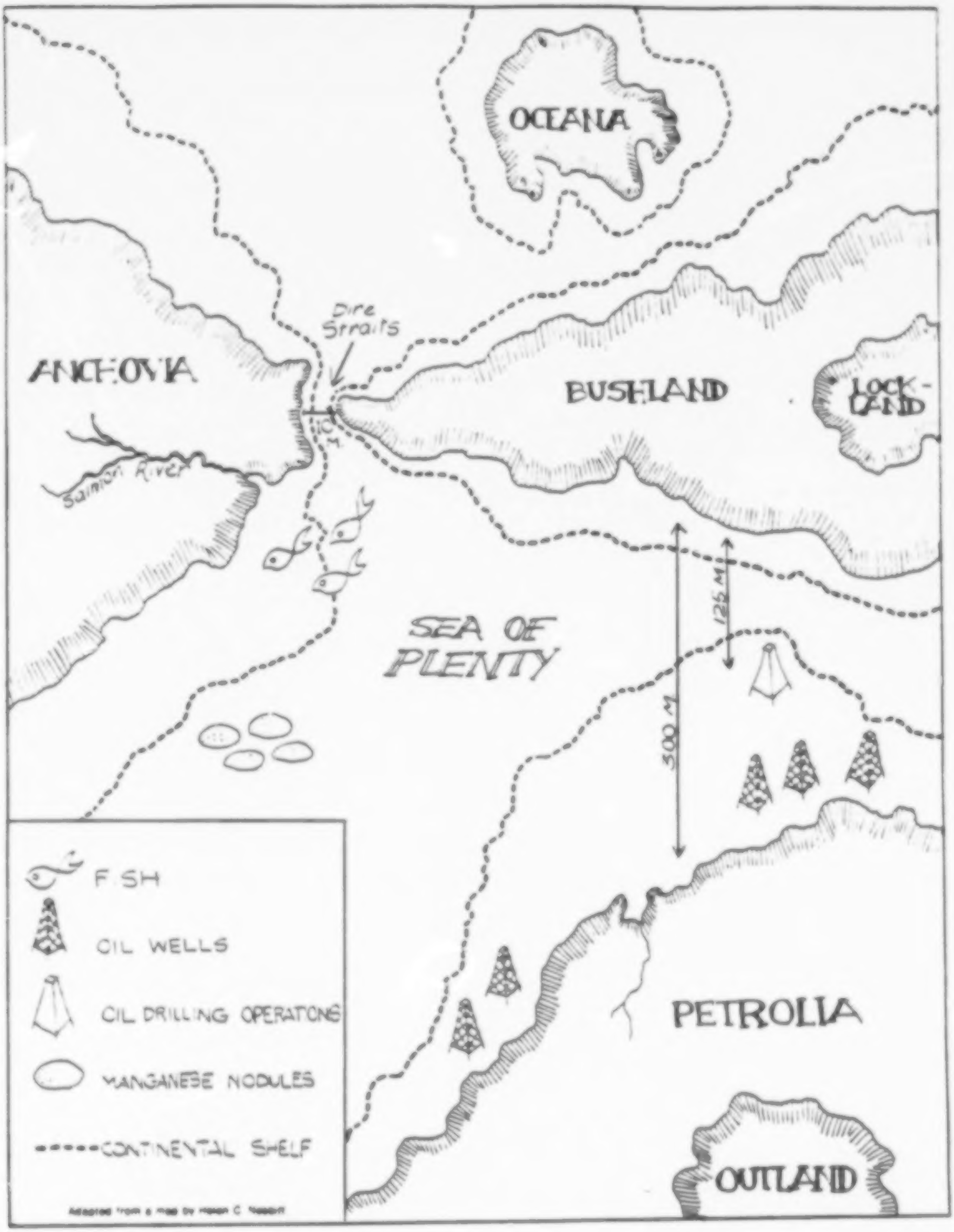
MAP OF THE SEA OF PLENTY


OCEANA
Dire Straits
ANCHOVIA
BUSHLAND
LOCK-LAND
10 M.
Salmon River
SEA OF PLENTY
125 M
300 M
PETROLIA
OUTLAND
FISH
OIL WELLS
OIL DRILLING OPERATIONS
MANGANESE NODULES
CONTINENTAL SHELF

Adapted from a map by Helen C. Nesbitt

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UNITED NATIONS LAW OF THE SEA CONFERENCE PROCEEDINGS

Basic Ideas of International Law

1. The oceans must remain open to all nations for the purposes of scientific study.

2. Any nation's activities must be conducted with due regard for the rights of other nations.

3. Any activity undertaken must be done in a way that maintains world peace and avoids adverse environmental effects.

Principles Governing the Seabed

On the basis of the work of the Seabed Committee, the General Assembly in 1970 adopted unanimously the Declaration Principles governing the seabed and ocean floor. Some of the major points are summarized below.

1. The seabed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction, as well as the resources of the area, are the common heritage of mankind; the area is not subject to appropriation and no state may claim or exercise sovereignty or sovereign rights over any part thereof; no state or person shall claim, exercise or acquire rights with respect to the area or its resources incompatible with the international regime to be established and the principle of the declaration.

2. The area is open to use exclusively for peaceful purposes.

3. The exploration of the area and exploitation of its resources are to be carried out for the benefit of mankind as a whole; any nation's activities must be conducted with regard for the rights of other nations.

4. States shall act in the area in accordance with the applicable principles and rules of international law, including the UN Charter, and in the interests of maintaining international peace and promoting international cooperation and mutual understanding.

5. Any activity undertaken must be conducted in a way that avoids environmental damage.

It is the first time in history that the concept of common heritage has found expression in an international instrument. It is perhaps even more significant that an area of at least 225 million square kilometers is reserved for mankind as a whole and will be administered by an international organization on its behalf.

31. FURROWS TO THE FUTURE

Introduction:

Developments in agricultural technologies have enabled humans to produce a surplus of food. The abundance of food freed some workers to specialize in other types of labor and eventually led to the growth of cities. Relatively small advances in technology thus greatly affected society. This lesson examines changes in plow technology that resulted in increased food production.

Objectives: Students will be able to:

1. Describe some significant developments in agricultural technologies.

2. Organize and present data in different ways.

3. Appreciate the importance of farming to modern life.

Subject/Grade Level: World history/grade 10; world geography/grades 7, 10; life science/grade 7

Time Required: 3 class periods

Materials and Preparation: Make copies of Handouts 31-1 and 31-2 for all students. Students will also need poster paper and markers. collect a variety of information sources on farming or insure that they are available in the library. *National Geographic* articles are especially helpful (see, for example, the September 1984 issue).

Procedures:

1. Pass out Handout 31-1. Discuss briefly the importance of farm machinery in contemporary Western farming. Allow students about five minutes to arrange the plow illustrations in chronological order:

D—3000 B.C. Egyptian

E—1000 A.D. Northwestern Europe

C—1900 A.D. American, European

B—1940 A.D. American

A—1987 A.D. Experimental American (A special blade travels horizontally just under the soil surface while twisted steel shanks dig deeply into the soil. This allows more effective weedkilling and greater water retention.)

Developed by Robert D. LaRue, Jr., Boulder Valley (CO) Public Schools.

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2. Have students keep their papers while the answers are discussed. Ask the following questions:

- What does plowing do? (Breaks up the soil) Why is that important? (Easier to plant; soil retains more water; kills weeds)
- What clues in the drawings helped you decide the order of development?
- How else might we group, or arrange, these plows? (By materials used to make them, by size, by method of propulsion, by probable size of the fields plowed by each, by area of origin)
- What is the main material used to construct plow D? (Wood) Plow C? (Steel) How did the change from wooden to steel plows affect the process of plowing? (Deeper furrows; could plow rockier land; sharper and thus faster; stronger and lasted more years)
- What is one major difference between plow D and plow E? C and E? A and B? What do these changes tell you about the rest of society?

3. Divide the class into groups of four. Distribute Handout 31-2 and review the directions for the poster activity.

4. The following day, reconvene the groups and check for understanding of the directions. Direct groups to the research materials and allow the rest of the period for research and work on the posters. Allow a few minutes the following day for groups to complete the posters.

5. Have each group present its findings by explaining its posters.

Extension/Enrichment:

Local farmers' organizations may have speakers available to discuss various aspects of farming, from technology and labor to financial and political issues. Another effective poster project is to assign each group a piece of agricultural technology from a particular era or geographical area (allowing students to compare farming practices around the world). Each group researches its item or area and produces a poster. The posters can be illustrated in chronological order to show change over time.

Resources:

Killengray, Margaret, *The Agricultural Revolution* (St. Paul, MN: Greenhaven Press, 1980).

National Geographic (September 1984).

White, Lynn, Jr., *Medieval Technology and Social Change* (London: Oxford University Press, 1964).

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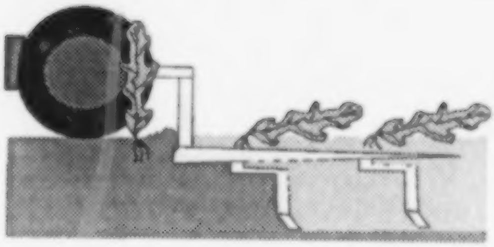
PLOWS THROUGH HISTORY



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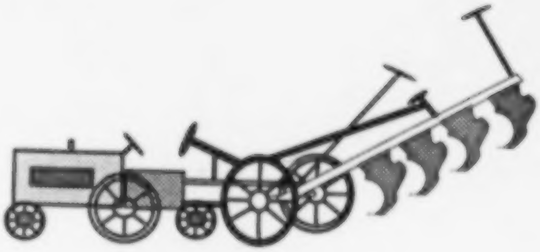

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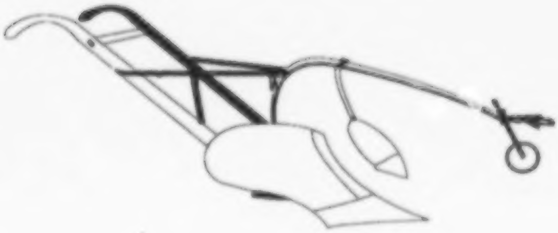

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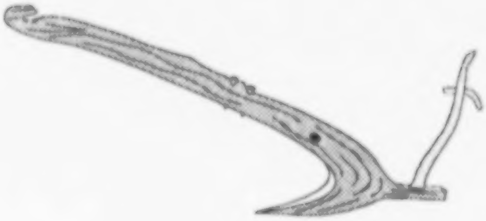

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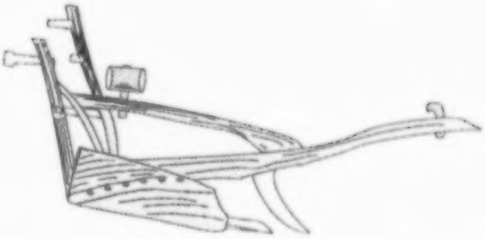

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POSTER ASSIGNMENT SHEET

Agriculture forms the essential base of civilization. Complex societies, regardless of their technological achievements, must first produce enough food to feed their people. The development of the plow helped insure that sufficient food was available to feed the non-farming city dwellers.

Your group is to explore the effects improved farm technology had on society. Divide these questions among your group members and search for the information in magazines, encyclopedias, and other books. When you have completed your research, transfer your information to a poster. On a second poster, use your research to predict the future of farming and its effects on society.

Questions to research for Poster #1:

1. How did the invention of the plow change farming?
2. How did the invention of the plow change the size of the fields?
3. How did the invention of the plot change the number of hours each farmer worked?
4. How did the invention of the plow change the amount of food produced? Why?
5. How did the cost of farm machinery change? Why?
6. How has technology affected the number of farms?
7. How has technology affected the price of food?
8. How has technology affected the quality of food?
9. How has technology affected the availability of food?
10. How has technology affected the ways food is sold?
11. How has technology affected family life?
12. What other technologies and sciences developed that had effects on farming?

Questions to research for Poster #3:

1. What will the farm of the future look like?
2. What technologies will the farm of the future have?
3. How will changes in farms affect society?

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32. THE INDUSTRIAL REVOLUTION IN JAPAN

Introduction:

The adoption of Western technologies has produced fundamental alterations in nearly every facet of traditional cultures in Asia and Africa. Until 1945, the Japanese were the only Asians to industrialize successfully in the face of a severe Western challenge. Hence their experience is in many ways unique. Yet a study of modernization in Japan can tell us much about the confrontation between East and West while at the same time revealing some of the distinctive characteristics of Japanese civilization.

As students work through this lesson, they should have several questions in mind: What about the heritage of the Japanese people explains why they were able to organize industrial institutions largely on their own initiative when other communities in the non-Western world were not? What particular aspects of the Western model did they accept? What aspects did they reject? What impact did the adoption of selected Western techniques have upon the established framework of Japanese society? How did the early results of modernization affect the subsequent course of Japanese (and thus world) history? What does the example of Japan tell us about the possible outcome of intense contact and interaction between two very different civilizations?

Objectives: Students will be able to:

1. Explain the basic steps by which Japan began to develop a modern industrial complex.
2. Give reasons why Japan was able to industrialize at an early date.
3. Describe some aspects of the impact of industrialization upon traditional Japanese society.
4. Test and evaluate conclusions through analysis of primary source documents.
5. Empathize with the experiences of a non-Western people confronted by challenges from the West and the far-reaching alterations associated with industrialization.

Subject/Grade Level: World history/grade 10

Time Required: 4-5 class periods

Materials and Preparation: You will need copies of Handouts 32-1 through 32-4 for all students. Students should have read background on Japan from their text prior to this lesson; names and dates are not critical, but an understanding of the fundamental nature of Japanese society on the eve of Commodore Matthew Perry's arrival in Tokyo Bay on July 8, 1853 is.

Adapted from "The Industrial Revolution in Japan," by John A. Mears, in Douglas D. Alder and Glenn M. Linden, eds., *Teaching World History: Structured Inquiry Through a Historical-Anthropological Approach* (Boulder, CO: Social Science Education Consortium, 1977).

Procedures:

1. Ask students to brainstorm what they know about Japanese society on the eve of Commodore Perry's arrival on July 8, 1853. Post students' responses on the chalkboard. If necessary, you may want to share the following information in a short lecture:

On the surface, it seemed as if the U.S. government had forced the Japanese to establish contacts with the outside world through a show of naval might supporting demands for trade relations and fueling stations. There is some truth to this picture, since Perry's visits did help to trigger drastic political and economic alterations within Japan by demonstrating once and for all its helplessness in the face of a challenge by powerful outsiders. This shock of recognition provided only an immediate stimulus for serious reform, however.

Despite two and one-half centuries of isolation deliberately imposed upon the country by the hereditary Tokugawa shogunate (1603-1867), far-reaching shifts in the prevailing social order had already pushed Japanese culture into a state of disequilibrium that severely threatened the status quo and made at least some Japanese leaders receptive to radical innovation. Their islands had enjoyed peace and stability under the Tokugawa regime. Population growth had created expanding markets for agricultural and manufactured goods, and this in turn led to the introduction of new quasi-capitalistic farming techniques as well as the development of commercial, banking, and other business enterprises upon which rapid industrialization could be built. Towns and cities increased in size, with Yedo passing the 1 million mark in the early 19th century. The expanding mercantile classes of Japan became steadily more independent and prosperous, while politically influential but economically poverty-stricken noble landlords and samurai fell ever more heavily into debt. Each of these groups could see their own interests served by a radical reorganization of customary societal patterns.

2. Distribute Handout 32-1. Allow time for students to read the three documents. Then conduct a discussion of the Japanese accounts about foreigners.

The first document in Handout 32-1 demonstrates yet another reason why Japanese leaders were so receptive to change: some of them recognized the relative weaknesses of their society and were strongly attracted to Western methods as an antidote to Japan's difficulties. A substantial body of scholars and intellectuals strove to absorb as much knowledge about Western science, technology, and medicine as possible. Even though the shogunate had attempted to restrict contact with foreigners, these informed Japanese had pursued Western ideas, especially through the writings of the Dutch, who had been allowed to maintain limited trading privileges in the port of Nagasaki. As a result, not all Japanese leaders were caught off guard by the events of 1853- 1854; at least a few had already given some thought to the question of how their society might be transformed to meet the Western challenge.

The first document reveals not only their appreciation for European learning but their ambivalence toward China—an ambivalence that made the acceptance of Western skills easier for many, since their forebears had imitated the Chinese for more than a millennium. Mid-19th-century Japanese leaders did not find it unduly painful to recognize European technical superiority and to borrow from the West any approach that seemed advantageous. They were, after all, turning their backs on old ways of doing things that were only partially indigenous to their own civilization. Insofar as the adoption of Western methods implied a rejection of things Chinese, the Japanese probably had an additional incentive to act, since they harbored long-standing resentments toward the culture from which they had appropriated so much.

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In contrast, the second document shows that the Japanese had mixed feelings about the Europeans as well. Here distrust of the outsiders' motives, especially when couched in religious terms, is plainly evident. Have your students react to the author's point of view. How do they respond to his description of the barbarians? The writer was an ardent nationalist named Hirata Atsutane (1776-1843), who accorded to Western learning a grudging respect, but who did not hesitate to attack the beliefs and actions of Europeans as means of arousing Japanese patriotism or asserting the comparative merits of Japanese culture.

The third document can be used to underscore some of the themes previously established: feelings of repulsion toward the intruders, a sense of inferiority in the face of American naval might, and an urgent desire to master the foreign languages necessary to learn about Western practices.

3. Before introducing Handout 32-2, an autobiography of a crusader for industrialization, remind your students of the political crisis precipitated by the demands of Commodore Perry. Unable to protect itself against the American barbarians, the Tokugawa regime destroyed what remained of its credibility and prestige by consenting to a series of unfavorable diplomatic agreements with various Western powers. When the shogun finally abdicated in 1867, reform-minded Japanese leaders took the occasion to proclaim a complete restoration of imperial authority, hoping to draw upon that authority to accelerate the program of modernization already initiated by the shogunate. What followed was the so-called Meiji era (1868-1912), during which many aspects of Japanese life underwent thorough-going Westernization. Recognizing that military strength was dependent upon an updated economic system, Meiji leaders did everything they could to encourage the advance of modern industry. By levying heavy taxes on agriculture, they were able to build essential factories and subsidize fledgling corporations, the costs of which were beyond the resources of private investors. Governmental officials thus exercised greater control over the initial stages of industrialization than had been the case in the countries of western Europe. At the same time, they abolished feudalism, adopted American forms of financial organization, established a French-style legal system, and built an army on the Prussian model and a navy that imitated the British example. In 1889 they promulgated a constitution that gave to Japanese politics the appearance of parliamentary rule.

Among the prominent individuals of the Meiji era who encouraged these reforms, none contributed more to the transformation of Japan than Fukuzawa Yukichi (1835-1901). He was an intellectual of samurai origins who traveled widely in America and Europe, discovering at first hand everything he could about the Western world. He later recalled his adventures in his autobiography, originally composed in 1898. The excerpts contained in Handout 32-2 tell us much about the mind-set of Fukuzawa and many of his late 19th-century countrymen. Along with an eagerness to absorb Western culture, he displayed an immense pride in Japanese accomplishments. Can your students detect his sense of confidence and self-esteem? What do they make of his confusion over the mysteries of English politics? Fukuzawa's discussion of representative government is important because it provides the student with an opportunity to analyze the difficulties involved in transmitting institutions and ideas from one cultural context to another.

4. Distribute Handout 32-3. This document, containing selections from a pamphlet published in 1897, will reveal to your students some of the reactions of Japanese workers to the spread of Western industrialism. The authors wanted to promote labor unity and encourage the organization of trade unions similar to those already operating in the United States. Have the class discuss the apparent impact of industrialization on the laboring classes. Do the comments about women and children bring to mind any parallels between the experiences of Japanese and Euro-

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pean workers? Stress the appeals to nationalistic sentiment pervading the first several paragraphs. Can your students explain the concern over family life expressed in this pamphlet? Now is a good time to point out to the class that the Japanese did not want to Westernize every aspect of their culture. They eagerly borrowed scientific ideas, technological devices, and organizational skills from the West, but had no intention of altering their own basic social institutions or value system. On the contrary, they saw in what they appropriated from the barbarians a means of protecting the core of their own civilization—a core that had, ironically, been threatened by the very outsiders from whom they were now trying to learn.

5. Distribute Handout 32-4. In this document, Kamei Katsuichiro argued that modernization had profound repercussions on traditional Japan. Like many of his contemporaries, Kamei was compelled to re-examine the direction of development in light of the horrendous defeats of World War II. Those defeats provoked a profound crisis in Japanese culture, laying bare the tensions and contradictions that had been building up throughout the 19th century. Events had demonstrated that East and West could not be reconciled as easily as many Meiji leaders had once supposed. Kamei found an explanation for the tragedy of 1945 in the tendency of recent generations of Japanese to turn their backs on Asia while pursuing Western ways. He called for a new approach—a return to the wisdom of the East, a rededication to long-standing values that would reduce the frictions so readily apparent in Japanese society following World War II. As your students discuss this handout, have them explore Kamei's ambivalent attitudes. Do they see the same dilemmas confronting other nations that are currently trying to industrialize?

6. Ask students to write an essay of four or five pages analyzing Japanese attitudes toward the West and industrialization. You can have them confine their reactions to the six documents at hand, or you can introduce supplementary materials of your own choosing. Encourage students to stretch their historical imaginations beyond the confining limits of their personal world to take a Japanese point of view.

Extension/Enrichment:

Students might further investigate some similarities between industrialization in the United States and Japan, particularly with respect to conditions workers faced and techniques that management used to keep workers from rebelling. If students are somewhat familiar with the conditions in which young women worked in the textile mills of Lowell, Massachusetts, for example, they might find the similarities with the silk and cotton mills in Japan interesting. Roughly 80 percent of employees in cotton mills were female; in the silk industry, the percentage of female employees was 94. They worked under inhumane conditions. The companies tried to keep the workers "in line" by providing songs for them to sing as they worked; these songs contained such lyrics as "Put all your strength into your work/It's for yourself/It's for your family/It's for the country of Japan." The workers responded by creating their own songs, with lyrics like the following: "Don't sneer at us/Calling us 'factory girls, factory girls'!/Factory girls are/Treasure chests for the company." Students might investigate these songs and create titles for the songs to reflect what the songs show about industrialization and Japan. A source for more information on the songs is E. Patricia Tsurumi, *Factory Girls: Women in the Thread Mills of Meiji Japan* (Princeton, NJ: Princeton University Press, 1990).

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JAPANESE VIEWS ON WESTERNERS

Document 1: Dutch Learning

The men of the countries of Europe sail at will around the globe in ships which recognize no frontiers. In Holland, one of the countries of Europe (though a small one), they consider astronomy and geography to be the most important subjects of study because unless a ship's captain is well versed in these sciences it is impossible for him to sail as he chooses to all parts of the world. Moreover, the Dutch have the excellent national characteristic of investigating matters with great patience until they can get to the very bottom. For the sake of such research they have devised surveying instruments as well as telescopes and helioscopes with which to examine the sun, moon, and stars. They have devised other instruments to ascertain the size and proximity of the heavenly bodies. It may take five or ten years or even a whole lifetime for such research to be completed; when problems cannot be solved in one lifetime, scholars write down their own findings and leave the solution for their children, grandchildren, and disciples to discover, though it may require generations.

...Unlike China, Holland is a splendid country where they do not rely on superficial conjecture. When the Dutch come across matters which they cannot understand no matter how much they may ponder over them, they say that these are things beyond the knowing of human beings, and belong to *Gotto* (God), and that only with divine powers could such matters be comprehended. The Dutch thus never resort to wild conjectures. Their findings, which are the result of the efforts of hundreds of people studying scientific problems for a thousand years, have been incorporated in books which have been presented to Japan. I have seem them and that is how I happen to be able to write of them.

Document 2: The Source of Western Unity and Strength

The Western barbarians have independent and mutually contending states, but they all follow the same God. When there is something to be gained by it, they get together in order to achieve their aims and share the benefits. But when trouble is brewing, each stays within his own boundaries for self-protection. So when there is trouble in the West, the East generally enjoys peace. But when the trouble has quieted down, they go out to ravage other lands in all directions and then the East becomes a sufferer....

As to the Western barbarians who have dominated the seas for nearly three centuries...all they have is Christianity to fall back upon in the prosecution of their schemes... When those barbarians plan to subdue a country not their own, they start by opening commerce and watch for a sign of weakness. If an opportunity is presented, they will preach their alien religion to captivate the people's hearts. Once the people's allegiance has been shifted, they can be manipulated and

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Document 1 excerpted from Hirato Atsutane, *Kodo Taii* (originally written in 1811), in *Hiratu Atsutane zenshu*, Vol. I (Tokyo, Japan: Itchi-do, 1911-1918), p. 53. Document 2 excerpted from Takasu Yoshijiro, *Shinron Kowa* (Tokyo, Japan: Heibon-sha, 1941), pp. 198, 215. This statement was originally written in 1825. Document 3 excerpted from Charles Terry, *Skuma Shozan and His Seiken-roku*, unpublished master's thesis (New York: NY: Columbia University, 1951), pp. 58-86. Reflections originally published shortly after the fall of the shogunate in 1867-68.

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nothing can be done to stop it... The subversion of the people and overthrowing of the state are taught as being in accord with the God's will. So in the name of all-embracing love the subjugation of the land is accomplished. Though greed is the motive, it masquerades as a righteous uprising. The absorption of the country and conquest of its territories are all done in this fashion.

Document 3: Reflections on My Errors (Seiken-Roku)

28. The principal requisite of national defense is that it prevents the foreign barbarians from holding us in contempt. The existing coastal defense installations all lack method; the pieces of artillery that have been set up in array are improperly made; and the officials who negotiate with the foreigners are mediocrities who have no understanding of warfare. The situation being such, even though we wish to avoid incurring the scorn of the barbarians, how, in fact can we do so?...

30. Of the men who now hold posts as commanders of the army, those who are not dukes or princes or men of noble rank, are members of wealthy families. As such, they find their daily pleasure in drinking wine, singing, and dancing; and they are ignorant of military strategy and discipline. Should a national emergency arise, there is no one who could command the respect of the warriors and halt the enemy's attack. This is the great sorrow of our times. For this reason, I have wished to follow in substance the Western principles of armament, and, by banding together loyal, valorous, strong men of old, established families not in the military class—men of whom one would be equal to ten ordinary men—to form a voluntary group which would be made to have as its sole aim that of guarding the nation and protecting the people....

35. Mathematics is the basis for all learning. In the Western world after this science was discovered military tactics advanced greatly, far outstripping that of former times....In the *Art of War* of Sun Tzu, the statement about "estimation, determination of quantity, calculation, judgment, and victory" has reference to mathematics. However, since Sun Tzu's time neither we nor the Chinese have ceased to read, study, and memorize his teachings, and our art of war remains exactly as it was then. It consequently cannot be compared with that of the West. There is no reason for this other than that we have not devoted ourselves to basic studies. At the present time, if we wish really to complete our military preparations, we must develop this branch of study....

47. In order to master the barbarians...there is no better first step than to be familiar with barbarian tongues. Thus, learning a barbarian language is not only a step toward knowing the barbarians but also the groundwork for mastering them. When the various nations on one pretext or another began sending ships frequently to the territory around Sagami and Awa, I thought it genuinely difficult to find out facts about them. As a result, I felt the desire to compile a lexicon in several volumes, translating other languages into Japanese, in order to teach the tongues of the various European countries. Also, since we have long had trade relations with Holland, and since many of us already know how to read the books used in that country, I wished to publish the Dutch section first. Before this, there had been order from the government to the effect that all books to be published must undergo official inspection....

49. Last summer the American barbarians arrived in the Bay of Uraga with four warships, bearing their president's message. Their deportment and manner of expression were exceedingly arrogant, and the resulting insult to our national dignity was not small. Those who heard could but gnash their teeth....

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FUKUZAWA YUKICHI—AUTOBIOGRAPHY

But it was a few months after the coming of Commodore Perry. And the news of the appearance of the American fleet in Yedo had already made its impression on every remote town in Japan. At the same time the problem of national defense and the modern gunnery had become the foremost interest of all the samurai. Now, all those who wanted to study gunnery had to do so according to the instruction of the Dutch who were the only Europeans permitted to have intercourse with Japan after the seventeenth century.

One day my brother told me that anyone who wanted to learn Western gunnery must study *gensho*.

"What is *gensho?*" I asked.

"*Gensho* means books published in Holland with letters printed sideways," he replied. "There are some translations in Japanese, but if one wishes to study this Western science seriously, one must do so in the original language. Are you willing to learn the Dutch language?"...

In Yedo, though the country's intercourse with foreign lands was yet at its beginning, there were constant demands for the Western knowledge from the government offices and from the various feudal nobility resident there. consequently anyone able to read foreign books, or make any translation, secured the reward of this patronage. There was even the possibility of a poor language student being made a high salaried samurai of several hundred *kuko* overnight.....

I am willing to admit my pride in this accomplishment for Japan. The facts are these: It was not until the sixth year of Kaei (1853) that a steamship was seen for the first time; it was only in the second year of Ansei (1855) that we began to study navigation from the Dutch in Nagasaki; by 1860, the science was sufficiently understood to enable us to sail a ship across the Pacific. This means that about seven years after the first sight of a steamship, after only about five years of practice, the Japanese people made a trans-Pacific crossing without help from foreign experts. I think we can without undue pride boast before the world of this courage and skill....

As I consider all the other peoples of the Orient as they exist today, I feel convinced that there is no other nation which has the ability or the courage to navigate a steamship across the Pacific after a period of five years of experience in navigation and engineering. Not only in the Orient would this feat stand as an act of unprecedented skill and daring. Even Peter the Great of Russia, who went to Holland to study navigation, with all his attainments in the science could not have equaled this feat of the Japanese. Without doubt, the famous Emperor of Russia was a man of exceptional genius, but his people did not respond to his leadership in the practice of science as did our Japanese in this great adventure....

Excerpted from *The Autobiography of Fukuzawa Yukichi* by Fukuzawa Yukichi. Copyright © 1966 by Columbia University Press. Reprinted with permission of the publisher.

During this mission in Europe I tried to learn some of the most commonplace details of foreign culture. I did not care to study scientific or technical subjects while on the journey, because I could study them as well from books after I have returned home, but I felt that I had to learn the more common matters of daily life directly from the people, because the Europeans would not describe them in books as being too obvious. Yet to us those common matters were the most difficult to comprehend.

For instance, when I saw a hospital, I wanted to know how it was run—who paid the running expenses; when I visited a bank, I wished to learn how the money was deposited and paid out. By similar first-hand queries, I learned something of the postal system and the military conscription then in force in France but not in England. A perplexing institution was representative government.

When I asked a gentlemen what the "election law" was and what kind of an institution the Parliament really was, he simply replied with a smile, meaning I suppose that no intelligent person was expected to ask such a question. But these were the things most difficult of all for me to understand. In this connection, I learned that there were different political parties—the Liberal and the conservative—who were always "fighting" against each other in the government.

For some time it was beyond my comprehension to understand what they were "fighting" for, and what was meant, anyway, by "fighting" in peace time. "This man and that man are 'enemies' in the House," they would tell me. But these "enemies" were to be seen at the same table, eating and drinking with each other. I felt as if I could not make much out of this. It took me a long time, with some tedious thinking, before I could gather a general notion of these separate mysterious facts. In some of the more complicated matters, I might achieve an understanding five or ten days after they were explained to me. But all in all, I learned much from this initial tour of Europe....

The final purpose of all my work was to create in Japan a civilized nation, as well equipped in both the arts of war and peace as those of the Western world. I acted as if I had become the sole functioning agent for the introduction of Western culture. It was natural then that I would be disliked by the older type of Japanese, and suspected of working for the benefit of foreigners....

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A SUMMONS TO THE WORKERS

The year 1899 will see Japan really opened to foreign intercourse. It will be a time when foreign capitalists will enter our country and attempt to amass millions in profits by exploiting our cheap labor and our clever workers. In such a situation, these foreign capitalists, who are not only different in character, manners, and customs, but who are also notorious for their cruel treatment of workers, will try to become your masters within the next three years. In the light of this situation, you workers must soon start to prepare yourselves or you cannot help suffering the same abuses as the workers of Europe and America. Considering recent developments, moreover, the relations between the workers and employers of our country will in the same way as in Europe and America undergo daily change as factories and plants increase in number.

Considerations of profit alone will prevail. The strong will be triumphant and the weak will be destroyed. Since the superior are heading for days of prosperity and the inferior for times of ruin, it will be no easy task to conquer and to flourish in the days that lie ahead. When, moreover, the foreigners do enter our country, it will be vitally necessary for you to double your resolution and to devise moderate means to protect your position on the field of struggle, without getting yourselves involved in scrapes on their behalf.

You workers, like others before you, are people without capital who provide a living for others than yourselves. One of your arms and one of your legs are, so to speak, devoted to the support of society. When you meet with some misfortune and are disabled or when you become infirm with age and can no longer work, you are immediately deprived of the means of earning a living and are turned out into the street. Should death overtake you, your wives and your children are hard put to stay alive. In this state of affairs you are really as helpless as a candle in the wind. Unless you workers heed the precept of the ancients and prepare for adversity while you are able, and make it your practice to provide for ways to cope with future difficulties while you are strong and sound of body, it will be hard for you to avoid transgressing the fundamental obligations of a human being, a husband, or a parent. This matter demands sober consideration.

In this day and age our country is still not enlightened. In the olden days, when there were no machines, your wives and children stayed at home and worked and helped to earn a living. But with the rise of factories and mills your wives, who would be looking after the home, take themselves off to work in the factories. And since even innocent children work at the machines, the life of the home is thrown into confusion. At times the lives of children are endangered, as machines, which should be of benefit to man, function improperly and present the astounding spectacle of doing him harm. In some factories children with delicate bodies are made to work hours which would be too long even for adults. The life-blood of those who are little more than infants is squeezed out with impartiality, and for their parents this is indeed unbearable. It should be evident that you must first and foremost take vigorous action and devise ways and means of coping with the situation. You must put your homes in order and protect the lives of your children and women. Do not forget, you workers, that those who take the lives of men do not do so only with the lethal instruments of murderers and criminals....

Excerpted from Katayama Sen and Nishikawa Kojiro, *Nihon no rodo undo* (Tokyo, Japan: Iwanami Shoten, 1952), pp. 18-22. Reprinted by permission of Iwanami Shoten, Publishers, 2-5-5 Hitotsubashi, Chiyoda-ku, Tokyo, Japan.

We would recommend, consequently, that you workers establish trade unions based upon the feelings common to men engaged in the same work and possessed of kindred sentiments. These trade unions, moreover, should be organized on a nationwide cooperative basis. In viewing carefully your past actions, it is evident that you have refrained from combining, that you have struggled with one another, and that you have achieved no unity. Thus, if there are some of you who have with laborious effort and after countless appeals finally secured an increase in wages, there are others who remain satisfied with their outrageously low wages. There are some who want to reprove your unworthy fellow workers but there are also those who want to protect them. The spectacle of some men building and other men destroying, of kindred people engaged in mutual strife, is really cause for regret.

Your internecine strife, the contempt in which the foreigners hold you, and the position in which you find yourselves today, all may be to a large extent attributed to the failure of you workers to act unitedly.

As has been indicated previously, attack by the foreign enemy may be expected. Today, when deplorable evils exist among you, you must stop your fractricidal struggles and see the necessity for engaging in a vast combined effort. You workers must not remain apart but should widely combine and keep pace with the advances of society. Inwardly you should nourish wholesome thoughts and outwardly comport yourselves in sober and steady ways. Shouldn't you seek to remedy the evil practices of your heartless employers and of the foreigners? Remember that there will be others who will think as you do.

Labor is holy. Combination is strength. It is for you who are engaged in holy labor to achieve the union that is strength.

KAMEI KATSUICHIRO—RETURN TO THE EAST

One of the problems with which Japanese have been burdened since the Meiji Era has been the necessity of examining Japan's place in Asia and our special fate as Asians. Japan, as everyone knows, was the first country in Asia to become "modernized," but it is not yet clear what meaning this modernization has for Asia. It is also a question whether Asian thought, which possesses strong traditions despite the repeated taste of defeat and a sense of inferiority before Western science, is doomed to perish without further struggle, or if it is capable of reviving in the twentieth century and contributing something which will enable us to surmount the present crisis. We must begin to consider these questions. In contrast with the fervor with which Europeanization has been pursued since the Meiji Era, this aspect of our lives has been extraordinarily neglected. I believe that the neglect—or perhaps one should say ingratitude—shown by Japanese toward Asia is the tragedy of modern Japan, and that to study it has become since the defeat of 1945 the greatest responsibility incumbent on us....

Looking back on Japanese history has revealed to me that in every age Asia has breathed in the minds of Japanese. We are all familiar with how Asian culture, transformed or more highly refined, became part of the flesh and blood of Japanese culture. However, like most young men of the past sixty or seventy years, I used not to consider Asia as being necessarily primary to us. My ignorance of and indifference to China and India did not trouble me in the least, and I was constantly fascinated by Europe. I thought that to learn from European knowledge was our first task, and I neglected the matter of learning from the wisdom of the East....

Japan, thanks to the fact that she was the first country in the Orient to become "modernized" (or perhaps on account of her modern military strength), began from about the time of the Russo-Japanese war to entertain attitudes of extreme superiority towards the peoples of Asia. This feeling, we must remember, was the reverse of the medal of our feeling of inferiority toward s the Europeans, and it came to express itself in a kind of brutality towards the other Asian peoples. We cannot deny that we tended to look on them as our slaves. When and how the fate of Japanese as Asians went astray is the most significant problem of our modern history.

The cause of the tragedy lies in our vigorous, precipitous modernization. We tried with desperate efforts to master European civilization, and in the act of acquiring it we lost something very precious—what I should like to call the characteristic "love" of Asia.

We cannot ignore the fact that this responsibility is connected with the singularity of our racial transformation. The period between the appearance of Perry's "black ships" at the end of the shogunate, and the completion of the battleship *Yumato* was a period when Japan was changing with extraordinary rapidity into "the West within the East." Indeed, if one were asked for what Japan poured out her strength most lavishly, and to what she devoted the finest flower of her scientific abilities during the years following the Meiji Restoration, one would have to answer that it was for warships. This emphasis on armaments must certainly have had its origins in the profound anxiety of our grandfathers who had seen before their eyes the nations of Asia being colonized, one after the other.

Excerpted from Kamei Katsuichiro, *Nijisseiki Nihon no risozo* (Tokyo, Japan: Chuo koron-sha, 1954), pp. 191-201.

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It undoubtedly represented an astonishing burst of energy displayed for the sake of national independence and self-defense, but, as fate would have it, the raw materials of the continent were necessary to it. One gets the feeling that in the matter of raw materials and the acquisition of markets Japan was hastily and sometimes crudely imitating the colonial policies of the European nations. We, first among the Asians, mastered the weapons which modern European civilization had employed to invade Asia in pursuit of its colonial policies, and we turned the points of these weapons on Asians. The modernization of Japan would have been impossible had we not victimized China and estranged ourselves from her. Japan has experienced this contradiction at least as a historical fact....

Japan carried out the European method of conquest: confronting other countries with weapons in one hand and a gospel of love in the other. Warships and Christianity were indivisible elements in the European conquest of Asia; Japan slaughtered people while preaching the love of Asia and the Way of the Gods....

Now, for the first time in modern Japanese history, Japan was furnished with the conditions of being able to deal with the nations of Asia on terms of equality—not as conquerors or as conquered, but on a genuinely equal footing. I should like to lay emphasis on this factor for which our defeat was responsible. The basis for Japanese independence is to be found here—by which I mean that it is the only ethical basis we have for independence...

As a basis for this return (to Asia) Japanese traditions must be scrutinized afresh... A re-examination of Buddhism, Confucianism, and Taoism as they exist in Japan, together with a general re-examination of the characteristically Japanese types of learning and art as they have been influenced by these teachings, must be undertaken. I should like to call attention to the steady achievements of men in the fields of anthropology, Japanese literature, Chinese studies, and Buddhist studies. It is a question of the roots of the tree onto which European culture has been grafted, and this re-examination is essential if we are to discover the "individuality" of modern Japan which gives a native character to all our thought....

However, in so doing we must free ourselves from any infantile notions such as the simple schematization formerly in vogue here, according to which the East stood for the spirit and the West for material things. Indeed, the return to the East must not be accompanied by prejudices directed against the West or any form of Zenophobia. In fact, it should result in the destruction of the very sense of opposition between East and West which figured so prominently in our former ideas.

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33. GOD AND THE ALARM CLOCK

Introduction:

This lesson introduces value conflicts between societies. The scientific and technological advances that powered European imperialism were often used to lure subject peoples into Western religions. Not all colonial peoples accepted the illegitimate association of technology and religious truth. One such man was Prince Modupe, born in Guinea but later a resident of the United States. This lesson centers around an excerpt from his book, *I Was a Savage*, a description of his boyhood.

Objectives: Students will be able to:

1. Explain how Western missionaries used technology to "sell" their religion.
2. Analyze source material.
3. Respect the values of other cultures.

Subject/Grade Level: World history/grade 10

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 33-1. This activity could be controversial; if you have concerns about its use, check with your department chair or principal.

Procedures:

1. Ask students to speculate on whether there is any connection between religion and technology. Review information about Western colonization of Africa, Asia, Latin America, and Australia.

2. Distribute Handout 33-1. Inform students that they are to look for sentences that illustrate differences in values between the whites and the Africans. Allow time for student reading.

3. Discuss the following questions:
   - How did whites connect material technology and spiritual beliefs? What were their goals? What was the usual African reaction to that position?
   - Out of all of the technological artifacts he must have seen, why did Modupe choose the alarm clock as his main example? What was the analogous African technology? Is one technology inherently "better" that the other? Why? What cultural values are expressed in the two different technologies for measuring time?
   - What does Modupe think about the missionaries' misuse of technology to gain converts?

Developed by Robert D. LaRue, Jr., Boulder Valley (CO) Public Schools.

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- How do you think his discovery affected his attitude toward technology? Toward Christianity? Cite evidence in the reading to support your position.

4. To close the activity, write on the board: "Conflicts of values and technologies of different cultures are..." Have students complete the thought by writing a short paragraph.

Extension/Enrichment:

Encourage students to do additional reading on religion and technology. How have religious organizations used technology—to gain converts and to get their message across?

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GOD AND THE ALARM CLOCK

Christian missionaries often used Western technology to get Africans to join the church. Some Africans recognized the dishonesty of associating the two. One such man was Prince Modupe. The following selection was taken from a book written by Prince Modupe.

One day I was reading along in First Corinthians when none of the words seemed to make much sense or to be of special interest. The day was drowsily, dreamily hot. A fly buzzed around my head, distracting me. I was about to give up when a certain few words popped up at me as though they had been in larger print, in bolder ink. They seemed to have no connection in meaning to any of the words before or after them

"There is one glory in the sun, and another glory in the moon, and another glory of the stars...."

I stopped reading, I repeated the words over aloud to myself. Into my mind flashed the sight of my grandfather bending thoughtfully over the sundial he made by crisscrossing straws over a gourd. I saw him in my imagination as clearly as though my feet were in Dubricka. I saw every line in his good, kindly, noble face. I knew that he never looked at his homemade time device without feeling in his venerable bones the glory of the sun, that other glory of the moon, that further glory of the stars. He often spoke to me about these things. He meditated upon them.

A chill of excitement ran through me. I shivered with it as though in a fever chill, in spite of the heat of the day. I had found my first clear answer to the confusions that deviled me! THE GLORY OF GOD WAS NOT IN AN ALARM CLOCK! THE GLORY OF GOD WAS IN THE SUN AND THE MOON AND THE STARS! The Bible had carried God's mouth to me on that and I knew it for truth.

Perhaps I could have arrived at this sooner and with less mental anguish had not that first white man who came to Dubricka showed us mechanical gadgets as evidence of the power of God. Only one article in his "juju kit" was of spiritual import—the Bible. Every other thing with which he tried to impress and convert our people was not an artifact of his religion but a representative item from his machine civilization. He had led us to believe that white nations had guns and steamships and skyscrapers and mirrors and matches, while the black tribes had none of these things, because the white God was more powerful. White men had accredited their own brilliant inventions to their God in an attempt to enhance God's power. As though God needed an alarm clock to be great! The greatness of God was in every stick and stone and star, just as we had been taught in the Dondo Bush. If God had a face, which seemed more improbable than ever now, that face bore more resemblance to my grandfather's when he felt the sun blessing his old bones than it did to the crafty visage of a spying policeman.

Excerpt from *I Was a Savage*, by Prince Modupe, copyright © 1957 by Harcourt Brace and Company and renewed 1985 by Prince Modupe Paris, reprinted by permission of the publisher.

34. THE EFFECTS OF INDIVIDUAL ACTIONS ON TECHNOLOGY AND SOCIETY

Introduction:

Even in the largest, most complex projects, decisions made by individuals can have profound effects. While those effects are first felt within projects, they also have implications and impacts on entire societies. This lesson examines the decisions of two scientists who played central roles in the development of America's modern space and atomic sciences.

Objectives: Students will be able to:

1. Describe the work of Werner Von Braun and Leo Szilard.

2. Use a decision tree.

3. Appreciate the responsibility scientists exercise in making decisions.

Subject/Grade Level: World history/grade 10; U.S. history/grade 11; government/grade 12; physics/grade 12

Time Required: 2 class periods

Materials and Preparation: Make an overhead transparency of the example decision tree, "Washington Attends the Convention." Make copies of Handout 34-1 for all students and enough copies of Handouts 34-2 and 34-3 for half the class.

Procedures:

1. Ask students if they think scientists ever have doubts about the projects they are working on. Let them speculate on the scientific advances or technological developments they think might have raised such doubts.

2. Next ask what a scientists might do if he/she had serious doubts about a project. How might they go about deciding what their response should be? After students have suggested some possibilities, tell them they will have a chance in this lesson to use a tool for making decisions to consider the dilemmas faced by two real-life scientists.

3. Distribute Handout 34-1 to all students. Project the "Washington Attends the Convention" transparency and allow time for students to examine it. Explain to students that the decision tree is an analytical tool that helps students study the decisions of others as well as make their own

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Adapted from *Turning the Tide: Technology Infusion Project* (Harrisburg, PA: Pennsylvania Department of Education, 1984) and *Lessons on the Constitution*, by John Patrick and Richard C. Remy (Boulder, CO: Social Science Education Consortium and Washington, DC: Project '87, 1986). Used by permission of the Pennsylvania Department of Education and the SSEC.

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decisions. It is based on a problem-solving procedure that involves mapping the likely alternatives and consequences of an occasion for decision. Decision trees graphically show the four key elements of decision making. These elements are:

- *Confronting the need for choice—an occasion for decision.* An occasion for decision is a problem situation where the solution is not obvious. For example, Washington, an advocate of a strong central government, was invited to attend the constitutional convention. Yet Washington also faced serious personal problems that needed to be dealt with at home.
- *Determining important values or goals affecting the decision.* One goal for Washington was to deal with his problems at home. Another goal, however, was to strengthen the government of the United States of America.
- *Identifying alternatives.* Alternatives in this situation were to attend the convention or to stay at home.
- *Predicting the positive and negative consequences of alternatives in terms of stated goals or values.* Washington considered likely consequences of his choices. For example, to attend the convention could lead him to neglect family problems. Missing the convention would forfeit his opportunity to help improve the government. However, staying at home would avoid any political risks, if the convention failed.

Point out to students that there is no one "correct" or "right" place to start on a decision tree. Sometimes students may start at the bottom with *alternatives* and work up. With other problems it may be more natural or appropriate to begin by considering the *values or goals* in a problem and work down. The students' perception of the goals involved in a decision or the alternatives available may change as they work their way through the decision tree.

4. To half of the class, distribute Handout 34-2; to the other half, give Handout 34-3. Have students read through their timelines. Note that on each reading an "Occasion for Decision" has been indicated with an asterisk. Students may use the indicated occasion for decision as a basis for completing the decision tree or they may choose a different occasion for decision if they prefer. Allow the balance of the period for students to fill out the decision tree.

5. Have one student summarize Von Braun's life; then have a second student summarize Szilard's life. Have another volunteer explain the decision tree for Von Braun. Repeat for Szilard.

6. Have students compare the goals, values, and methods of the two men. Stimulate thinking using the following questions:

- What do students think about Szilard's call for secrecy? About Von Braun's alliance with the Nazis? What do their decisions show about their values?
- Which man made the "better" choices? How did students define "better"?
- What positive and negative consequences did each decision have?
- What conclusions can we draw about scientific decisions and the people who make them?

Extension/Enrichment:

Have students cut out newspaper or magazine articles about recent decisions relating to science. Have them list the factual questions that decision-makers identified in considering alternatives and their consequences. What values and value judgments were critical to the decision? Decision trees could be completed for the decisions students locate.

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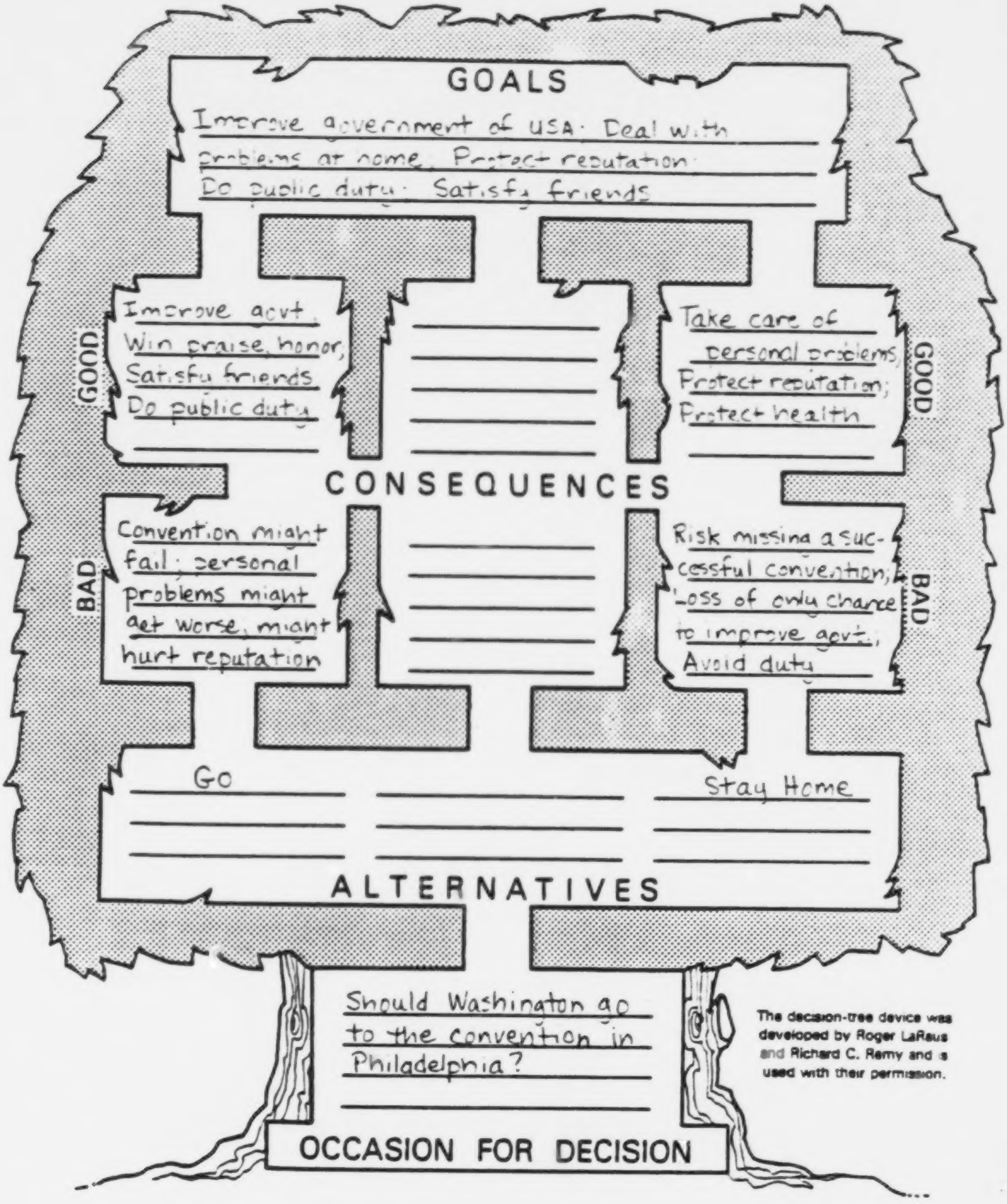
SAMPLE DECISION TREE



GOALS

Improve government of USA; Deal with problems at home; Protect reputation; Do public duty; Satisfy friends

CONSEQUENCES

GOOD

Improve govt.; Win praise, honor; Satisfy friends; Do public duty

GOOD

Take care of personal problems; Protect reputation; Protect health

BAD

Convention might fail; personal problems might get worse; might hurt reputation

BAD

Risk missing a successful convention; Loss of only chance to improve govt.; Avoid duty

ALTERNATIVES

Go

Stay Home

OCCASION FOR DECISION

Should Washington go to the convention in Philadelphia?

The decision-tree device was developed by Roger LaRaus and Richard C. Remy and is used with their permission.

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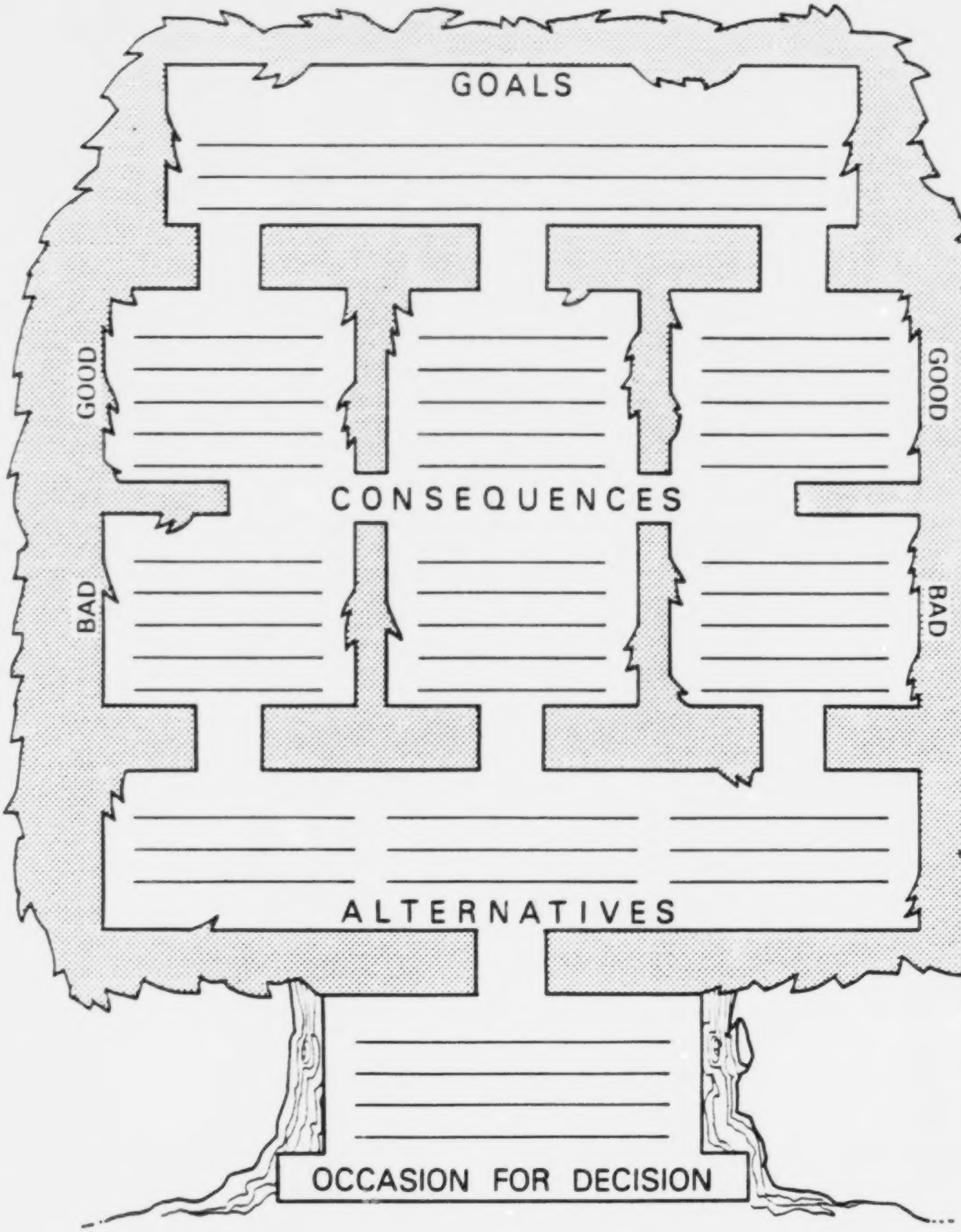
BEST COPY AVAILABLE

DECISION TREE


GOALS
GOOD
GOOD
CONSEQUENCES
BAD
BAD
ALTERNATIVES
OCCASION FOR DECISION

The decision-tree device was developed by Roger LaRaus and Richard C. Remy and is used with their permission.

WERNER VON BRAUN—A WAY TO THE START

The following is a chronology of events related to V-2 development in Nazi Germany.

1912—Von Braun is born on March 23.

1929—German army begins active interest in rockets as weapons because of the Versailles treaty ban on long-range artillery.

1930—Von Braun begins experimenting with liquid-fueled rockets.

1931—At this time, as remembered by Von Braun, his father warned of the consequences if Hitler attained power.

1932—Von Braun receives engineering degree. He fires small rockets for Army observers in September and October.

*He is hired as the first civilian employee by the Army and is placed in charge of rocket development. Von Braun said:

> "...we were interested solely in exploring outer space...but we needed money."

1933—Hitler takes control of the German government in January.

—Von Braun has reasonable successes with small rockets.

—Many begin efforts to leave Germany; some succeed.

1934—Von Braun receives doctoral degree.

—In December, an A-2 (early V-2) reaches an altitude of 6,500 feet.

1936—Hitler expresses interest in rockets as weapons.

—Pennemunde site, selected by Von Braun, is purchased in December.

1937—Von Braun progresses to the A-3 (1,650 pounds, 21 feet long), which had guidance problems.

—Goals for the rocket weapon are established by comparison to the WWI Paris Gun:

Paris Gun—range—80 miles, payload—23 pounds
A-4 (V-2)—range—180 miles, payload—2,220 pounds (1,000 kilograms)

1938—A revised A-3 is fired; it has a range of 11 miles.

1939—Hitler observes firings in March and is not impressed.

—Poland falls in September.

—An advanced A-3 reaches an altitude of 7.5 miles.

1940—France falls in June.

—Pennemunde cutbacks ordered as Hitler loses interest.

—Von Braun joins Nazi Party.

1942—First A-4 fired in June (47 feet long, 13.5 tons total, 1 ton warhead).

—Third A-4 fired in October with impressive results; it reaches an altitude of 30 miles, breaks the sound barrier, and has a range of 118 miles. Films of this shot are used when Von Braun visits Hitler to obtain further support.

1943—In July Hitler is impressed by films, models, etc.

—Von Braun is awarded an honorary degree for his work.

—Pennemunde is bombed by the RAF. Raids continue for next 13 months.

1944—By early 1944, V-2s are being mass produced. They give poor test results. At Von Braun's insistence, special test models are prepared. He personally supervises tests, which pinpoint production problems, and test results improve. Mass production resumes.

—Von Braun is arrested by the Gestapo in March after refusing to aid Himmler in getting Pennemunde under SS control. He is released after a direct order from Hitler is secured.

—The first V-2 hits London in September.

1045—Pennemunde is captured by the Russians in May.

—Von Braun arranges surrender to U.S. forces.

—Von Braun comes to the United States and is immediately a prime mover in the American space program. Von Braun's Nazi A-7 long-range missile design becomes the U.S. Redstone missile and is used for several early satellite launches.

—Von Braun is entered into the American Aviation Hall of Fame.

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LEO SZILARD—SCIENTIST WITH A SECRET

The first three decades of the 20th century produced phenomenal growth in the field of physics. As the Nazi war machine prepared for its assault on Europe, a few scientists realized that a nuclear fission chain reaction was not only feasible, but also a source of incredible energy. One of those physicists, Leo Szilard, made every effort to prevent publication of experimental results from studies of nuclear fission. A chronology of events follows:

1933—Szilard is among the first to recognize the possibility of a fission chain reaction.

1934—Joliet and Curie (France) verify that artificial radioactivity is possible.

—Szilard (working in England) patents his work and gets the British government to declare his work secret.

1935—Szilard attempts to start a "conspiracy of silence" in the general field of nuclear physics by requesting other physicists to restrict publication of experimental results. His idea is rejected.

1938—Data verifying that neutrons cause uranium fission is obtained by a group of physicists in Germany as well as by physicists working in Denmark and Sweden.

1939—Szilard approaches Fermi (both now working in the United States) about the need for secrecy. Fermi calls Szilard idea "Nuts"!

—Szilard approaches the French research group, requesting they hold back publication. They hesitate, but eventually publish their results.

—In March German troops invade Czechoslovakia.

—Shortly after the invasion, information from several sources is published, verifying all of the following: neutrons are produced by uranium fission; each fission produces two or three new neutrons; U_{235} is fissionable, but U_{238} is not. All these observations required very sophisticated techniques, and the work was only being done in the United States and France.

—Several German scientists describe possibilities of fission to the German government after publication of the above data.

—Soviet fission research is also begun.

—Awareness of the need for secrecy spreads in the United States.

*Einstein, urged on by Szilard, wrote to President Roosevelt to outline the state of nuclear research and to express alarm at the possible outcomes should Germany develop atomic weapons first.

1940—Szilard withholds his own paper on nuclear reactors.

—Szilard convinces an American, Herbert Anderson, to withhold publication of a paper describing neutron absorption in uranium.

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—Fermi and Anderson discover the feasibility of carbon as a neutron moderator.

—Szilard persuades Anderson and others to withhold publication of their data over Fermi's strong objections.

—German physicists were reaching the wrong conclusion about moderators and had decided that the rare isotope, deuterium (heavy water), was necessary. They were never able to obtain enough to test their ideas—if they knew that the readily available carbon (as graphite) would work, they might possibly have had sufficient data to produce both nuclear reactors and nuclear weapons.

—Szilard stops publication of a paper describing plutonium production.

—Finally, Szilard gets enough support to have the National Academy of Scientists impose censorship.

1942—The Manhattan Project is set up to research nuclear reactions and determine the feasibility of atomic weapons.

1945—Szilard, along with six other scientists of the University of Chicago Committee of Social and Political Implications, signs a petition protesting the expected use of atomic weapons on Japan. The group proposed a non-lethal demonstration before United Nations representatives as one way to convince Japan to surrender.

—Szilard gives up physics and enters the field of biological research.

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35. INVENTIONS TODAY AND YESTERDAY

Introduction:

In this activity, students examine the intended and unintended consequences of various inventions, coming to realize that all inventions have such externalities. The economic definition of *externalities* is that people involved in actions do not bear the full cost or receive the full benefit of their actions. Decisions may cause consequences, often unforeseen, for which the person making the decision may not want to accept responsibility. Decisions about the development of technologies always involve externalities.

Since all technologies have unintended consequences, understanding the notion of externalities is an important aspect of understanding the nature of technology. Furthermore, while inventors cannot anticipate all the effects of their inventions, consideration of possible effects is part of the technological process.

Students begin the activity identifying unintended consequences of modern-day inventions. Following this activity, they are introduced to the term *externalities* and apply the concept to a historical case study, Sam Slater's introduction of the cotton mill in the United States. Finally, students develop new technologies—toys—and try to anticipate the externalities of their inventions. Much of the lesson is conducted in cooperative groups of three students.

Objectives: Students will be able to:

1. Recognize that technologies have intended and unintended effects.

2. Define the economic term *externalities*.

3. Identify the externalities of given historical and contemporary inventions.

4. Describe how consideration of externalities affects the creative process in developing technologies.

Subject/Grade Level: U.S. history/grade 8

Time Required: 5-6 class periods

Materials and Preparation: Make copies of Handout 35-1. Collect the following materials for use in the lesson: one or more potentially dangerous toys; a selection of modern-day inventions, such as a walkman radio, a calculator, a remote control device, a hand-held video game, and so on.

Developed by Jean Hamlin, Mesa (AZ) Public Schools.

Procedures:

1. Display a toy that could be potentially dangerous. Brainstorm with the students the potential dangers. Ask students whether they think the inventor of the toy realized it could be dangerous when he/she invented it. Allow students to brainstorm a list of toys and games that have had unintended consequences, both negative and positive.

2. Give each cooperative group a contemporary invention, such as a walkman radio, a calculator, an electric toothbrush, a hand-held video game, a remote control device, and so on. In their groups, students should devise a list of the unintended consequences—both positive and negative—of their invention. You may want to walk through one device as a class to model the process for students.

3. Call randomly on one person from each group to share with the class the positive and negative consequences they identified for their inventions. Ask the presenters to provide evidence for each of the consequences they list. Ask the following questions:

- Were there any inventions for which you could come up with no unintended consequences?
- Do any of you disagree with the way in which consequences have been classified as positive or negative?
- What might the inventors have done differently if they had been aware of the unintended negative consequences when they designed the invention?

4. Tell students that it is not just modern inventions that have externalities. Technologies throughout history have had unintended consequences. Today students are going to identify externalities for the introduction of one new technology in the United States.

5. Give students copies of Handout 35-1. Allow time for students to read the handout. Then have them work in their cooperative groups to discuss the externalities that resulted from Sam Slater's establishment of textile mills in the United States.

6. Conduct a class discussion of the groups' opinions regarding the externalities involved in the historical case study. Ask: Why is it important to know that technologies have unintended effects? Does knowing about these unintended effects change the way we think about inventors or inventions? Why or why not?

7. Tell students that they are going to work in their groups to design toys that kindergarten students would enjoy. Brainstorm with the students some of the factors they might need to consider when designing a toy. Record their ideas and devise a list of criteria for groups' use in the design process. The following questions may be used as a starting point for discussion:

- What do kindergarten students enjoy doing?
- Will the toy be fun for them?
- What kind of materials will be needed to make this invention?
- Will the toy be safe?
- How many kids can play with this toy at one time?
- Does the toy have more than one use?
- What negative consequences might this toy have?

2 3

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8. After the brainstorming and establishing of criteria, allow time for the groups to design their toys. Urge students to think of as many consequences of making the toys as they can. The toys should be sketched on paper with a brief description that presents answers to questions included in the criteria the class agreed upon.

9. When groups have completed their designs, have them trade designs. Each group should list possible externalities of the invented toy they have been given. The groups could then share their findings.

Extension/Enrichment:

Students could actually build their inventions and then observe kindergartners using them. What externalities do they note?

Interested students might follow-up on the content of the handout by researching work in the Lowell mills, particularly the work done by children. Other students might research other historically important inventions, such as the light bulb, electricity, the telephone, the computer, the cotton gin, gun powder, or automobiles. Their research should focus on the externalities of these inventions.

Students might also interview older adults about the externalities of an invention that they believe has changed their own and others' lives.

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SAM SLATER AND THE TEXTILE MILL

Sam Slater was a young Englishman. When Sam was 14 years old, his father's friend made Sam an apprentice in his factory. Sam was a very bright, enterprising boy and was soon given the important job of supervisor of the factory, even though he was very young. Sam learned all that he could about the factory, including how the yarn-making machine worked.

When Sam was 21, he heard that the United States was giving rewards for information about textile machinery. Because the English did not want people in the United States to learn how to produce inexpensive textiles themselves, English people who knew about the machine were not allowed to emigrate from England to the United States. Sam was eager to go to the United States and share his information; he dressed up like a farmer so he could board a ship to the United States.

Sam was fortunate to learn of Moses Brown of Rhode Island. Brown was trying to produce thread with a machine. Sam convinced Moses to rebuild the factory. With the financial backing of two other men and the help of skilled craftsmen who lived in Pawtucket, Rhode Island, the textile machine was built according to the plans Sam drew from memory.

When the first dam and factory house were being built, the dam was destroyed by some of the local craftsmen. The craftsmen did not like Slater. They believed his factory would threaten their way of life.

As more and more factories were built and people came to work in the factories, cities grew up around them. Lowell, Massachusetts, is a city that grew as a result of the building of the mills. Most of the workers in the factories in Lowell were young women. The story of these young women working in the factories is a famous one. A song has been written about them.

Many young people were fascinated with the idea of working in the cotton mills and soon left the farms to work in the mills. Young children also worked in the factory, even though this was not encouraged to the extent that it was in England. The way that families had lived changed when young people left the farms and young children worked in the factories.

Among the craftsmen who helped Sam Slater build the first mill was his brother-in-law, David Wilkinson. Because of this experience, David was able to use his inventive abilities to develop many machine tools that contributed to the machine tool industry in the United States.

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36. RENEWABLE ENERGY AND THE AMERICAN AGE OF WOOD

Introduction:

Renewable energy resources played a larger role in the development of industrial America than historians have generally acknowledged. Consequently, the uses of such energy sources as water power, wind power, and wood fuel have been relegated in most textbooks and classrooms to the quaint and superfluous. This activity attempts to correct such omissions by focusing on the role played by water power and wood as fuel during the 1840s and 1850s. The activity focuses on a decision faced by numerous 19th-century business enterprises, whether to use steam-powered engines or some alternative source of power.

Objectives: Students will be able to:

1. Evaluate data as to their usefulness in weighing alternative power sources.

2. Use data to defend a decision whether to utilize steam or water power.

3. Identify factors that influenced the use of energy in the 1840s and 1850s.

4. Identify the advantages and disadvantages of various forms of energy available in the 1850s.

5. Appreciate the importance of data in making decisions about science-related issues.

Subject/Grade Level: U.S. history/grade 11; economics/grade 12

Time Required: 4 class periods

Materials and Preparation: Make copies of Handouts 36-1 and 36-2 for all students. Prepare one set of Situation Cards and 10-15 copies of the Data Packet; you may wish to cut the items in the Data Packet apart and place each packet in a manila envelope. You will also need five overhead transparencies and markers.

Procedures:

1. Divide the class into five groups. Distribute Handout 36-1 to each student and review instructions with the class. Distribute a different Situation Card to each group. Also give each group two or three copies of the Data Packet.

2. Present the "Wood and Water as Energy" material, either through a lecture or student reading and class discussion of Handout 36-2.

Adapted from "Teaching About the Uses of Renewable Energy Sources During the Age of Wood," by Clair W. Keller, Professor of History, Iowa State University. Reprinted by permission of the author.

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3. Reassemble the groups and have them begin work on the written reports. Allow a full class period to complete the papers. Allow another full class period for students to work within their groups to determine the best power source for their customer. By the end of the period, they should have outlined their supporting points on the overhead transparency.

4. Have each group present its situation, recommendations, and reasoning. Post the following questions on the board and have each group respond to them following their presentation:

- What factor was the most persuasive in making your decision?
- What additional information would have been helpful?
- How valid was your group's decision?

The best solution for Situations A and C would be steam power. The Savannah Saw Mill (C) is an actual mill. The Philadelphia Ironworks (A) would use steam because steam was an urban development. It would also employ coal as fuel. Situation B, a real mill run by water power, is described in John Bordon Armstrong's, *Factory Under the Elms,* pages 22-28. Situations D and E are representative of small mills that continued to employ water power well into the late 19th century.

5. Conclude the lesson by discussing the following questions with the class:

- What factors determined the use of energy in America in the 19th century?
- Is it valid to equate steam power with industrialization? Discuss the validity of this statement: "The Industrial Revolution was based on the application of steam (with coal as the source of power) to the textile, milling, and lumber industries."
- What energy choices do manufacturers face today? What factors must contemporary industries consider when making energy choices?

6. Have each student write a paragraph analyzing the strengths and weaknesses of his/her group's decision.

Extension/Enrichment:

Students may wish to pursue the topic of changes in energy use over time. Community-based studies would be especially interesting. Differential billing rates for electrical power, fuel sources for local utilities, and the transformation of wastes into fuel could be topics for research.

Resources:

Clair W. Keller, *Involving Students in the New Social Studies* (Boston: Little Brown, 1974), pp. 41-56.

John Borden Armstrong, *Factory Under the Elms: A History of Harrisville, 1774-1869* (Cambridge, MA: MIT Press, 1969).

Carroll M. Pursell, Jr., *Early Stationary Steam Engines in America* (Washington, DC: Smithsonian Institution Press, 1969).

ASSIGNMENT SHEET

1. Your group is to represent an energy consulting firm. You make recommendations to business owners about the kind of energy they should use.

2. Each member of your consulting group is to review the material on "Wood and Water as Energy " and the Data Packet. Each member is to write a discussion paper that explores the advantages and disadvantages of using steam or water power in the situation described in your Situation Card. As a conclusion, each member is to decide which would be the most advantageous power source for the business you are advising. Defend the decision with specific facts from the Data Packet.

Due ______________________________

3. Meet as a group and decide which power source you will recommend to the business owner. Outline your reasons on an overhead transparency as the basis for a presentation to the class.

As you prepare your papers and your presentations, consider the following aspects of the problem:

a. Costs: initial investment, operation and maintenance, labor, buildings

b. Hazards: fire, flooding, droughts

c. Environment: cleanliness, pollution

d. Transportation needs

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WOOD AND WATER AS ENERGY

Wood

Brooke Hindle writes in the introduction to a collection of essays entitled *America's Wooden Age*, "In this country, a technology broadly based upon wood and a society pervasively conditioned by wood persisted until the mid-19th century when wood began, selectively, to be replaced by a rising utilization of other substances."[1] Wood was the major source of fuel, the primary building material, and a major source of chemical inputs such as potash and charcoal. As a result, the per capita consumption of wood in America increased during the first 70 years of the 19th century. America's consumption of wood was three and one-half times that of Great Britain.[2]

The availability of land was undoubtedly the strongest magnet attracting colonists to the North American shores. Closely related to the land, however, was the abundance of wood. Wood, like land, had become a scarce item in England and Europe. In 1623-1624, John Winthrop, who led the Puritan migration to Massachusetts, wrote that the scarcity of wood had driven the poor to constantly chop down not only young trees and hedges but gates and bridges as well.[3]

It should be pointed out, however, that tradition did not always give way to the forest. New England settlers continued to construct traditional English frame houses even though log cabins would have been ideal dwellings. Log cabins could have been built with the axe alone, without nails or other hardware!

Wood as a fuel for heating homes certainly influenced the growth of colonial America in many positive ways. The abundance of wood, for example, enabled colonists to live more comfortably than their counterparts in Europe. The colonists wasted a great deal of their space-heating energy by using inefficient fireplaces. When wood became increasingly expensive in urban areas because of transportation costs, the Franklin stove was developed to save fuel. Comfortably heated colonial houses contributed to the enormous population increase during the 18th century by decreasing the death rate among the colonists.

Wood as a fuel survived long after the arrival of the steam engine. The cheap and ready supply of wood along America's numerous waterways was a primary factor in the success and rapid expansion of the steamboat. A free and easily supplied source of fuel cut the cost of operating the steamboat and enabled it to become immediately competitive with other forms of transportation.

The availability of wood also influenced the spread of early railroads. Railroads ran on wooden rails and ties and spanned rivers and gulleys over wooden truss bridges. Locomotives were first made of wood rather than metal.

Wood was also a cheap fuel for railroads. When Americans imported English locomotives, they converted them from coal to wood. American-built locomotives were wood-burners. Wood served as the principal fuel used by locomotives during the 1830s and 1840s. Even naval vessels continued to use wood, rejecting a commission recommendation in 1844 urging naval vessels to shift to coal. Before coal-burning engines could become economically competitive, the inefficient methods being used to take care of coal residue had to be improved. These changes didn't come about until the mid-1850s.[4] Even then, wood-burning engines still dominated in New England and the South, where wood supplies were abundant, and in the West, where coal was scarce.[5]

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Water Power

American industry before the 1840s rested overwhelmingly upon water power. Even in 1870, according to the census of that year, 48 percent of the stationary power was provided by water power.[6]

There were several reasons for the limited use of steam power in the first half of the 19th century: (1) its high initial cost; (2) unfamiliarity with its operation, maintenance, and repairs; (3) high operation costs; (4) difficulty and cost of transporting heavy equipment, such as engines and boilers; (5) the widespread, familiar low-cost alternative—water power; and (6) the steamboat boiler controversy raising the issue of boiler safety.[7] One might add also that the cleanliness, smaller space requirements, and safety of water power encouraged its use.

The importance of water power was of long standing. Like the early Americans who saw the abundant forests, the first Europeans in America also marveled at the numerous rushing rivers and streams. An abundant water power supply eased the task of providing food, shelter, and clothing and certainly contributed to the high standard of living shared by most white colonists.

The first water wheels provided power for sawmills because there were abundant supplies of wood available long before large quantities of grain were available. The first sawmill was built on the James River in 1611. The Virginia company recruited German technicians from Hamburg to build a sawmill at the falls, thus making it possible to construct the new town of Henrico, which had three streets of well-framed houses.[8]

It is not surprising that sawmill technology, much of it imported from Europe, improved rapidly as the colonists sought to maximize the abundant resources of water and forest. Sawmills in colonial America antedated their introduction in England. Every new community established a sawmill as its first priority. The location of the sawmill often dictated the town's location.

Although water power dominated the industry, steam was utilized for sawmills as early as 1802. In that year in Philadelphia, an owner advertised that mill refuse could be used for fuel and wood ashes were excellent for fertilizer. The familiar hazards of water power—drought and flood—would be eliminated, the advertisement said. A coal-burning, steam-powered saw was reported in New York a few weeks later. Despite the claim that the sawmill would "soon make a fortune for the owner," most sawmills continued to be water-powered. In 1860, for instance, only 174 of Ohio's 437 sawmills were powered by steam.[9]

Soon after erecting a sawmill, the colonists built a gristmill, often at the same site. Although horizontal mills, which needed no gearing, had been used by the Greeks as early as 85 B.C., not all colonists could afford to build them. Many ground grain by hand. Early colonists sometimes used a simple devise called a plumping mill. This inexpensive and easily built water-powered gristmill operated like a teeter-totter with a wooden box that filled with water on one end and a pestle at the other end. "When the box was full, the weight forced the sweep downwards. The box then emptied on descent, thereby releasing the weight as it swung back again to the filling position. The counter weight, shaped like a pestle, dropped into a hardwood mortar in which the grain was placed, thus pounding the grain into a course flour."[10] Thus water power replaced the laborious task of pounding the grain by hand.

When communities built horizontal mills, they were often simple "tub wheel" mills designed to serve small communities or individual families. A stream of water was directed to a horizontal wheel, 4 or 5 feet in diameter, located beneath the mill. This turned a shaft connected to a mill stone attached directly above.[11] These horizontal mills were later replaced with the more efficient vertical water wheels, which operated by directing water to either the top (the most efficient method), middle, or bottom of the wheel. Using the vertical wheel required gearing to change direction of the power, something accomplished by the Romans. Gearing also enabled the millstone to turn at greater speed than the water wheel. Some water wheels were powered by the tide, filling a mill pond at high tide, then directing water to a wheel during low tide. They would operate for about 5 1/2 hours during each 24 hours.[12]

Some water-powered gristmills operate today, not because they are economically sound (although this may soon be the case) but because the meal, which absorbs the dampness of the mill site and has been ground finely on slow-turning old stones, produces exceptional bread.

Summary

The Americans relied on wood and water as sources of energy well into the last half of the 19th century. These energy sources were well suited to a predominantly rural and agricultural society. The steam engine powered by coal, diesel, or gasoline is a phenomenon of the city, where forests and bubbling brooks seldom exist. The high energy costs at today's market place may make wood and water power more than just a nostalgic harkening toward the past.

Footnotes

1. Brook Hindle, "The Span of the Wooden Age," in Brook Hindle, ed., *America's Wooden Age* (Tarrytown, NY: Sleepy Hollow Restorations, 1975), p. 3.
2. Charles Carroll, "The Forest Society of New England," in Hindle, *op. cit.*, p. 5
3. *Energy, Engines, and Industrial Revolution* (Washington, DC: U.S. Department of Energy, August 1979), pp. 43-44, 51.
4. Edward Keuchel, "Coal Burning Locomotives: A Technological Development of the 1850's," *Pennsylvania Magazine of History and Biography*, Volume 94 (October 1970), p. 486.
5. *Ibid.*, p. 485.
6. Louis Hunter, "Waterpower in the Century of the Steam Engine." in Hindle, *op. cit.*, p. 170.
7. *Ibid.*, pp. 172-173.
8. Charles Peterson, "Early Lumbering: A Pictorial Essay," in Hindle, *op. cit.*, p. 66
9. *Ibid.*, p. 76.
10. Charles Howell, "Colonial Waterwheels in the Wooden Age," in Hindle, *op. cit.*, p. 121.
11. *Ibid.*, pp. 24-30; Hunter, *Waterpower in the Century of the Steam Engine* (Charlottesville, VA: University of Virginia Press, 1980), pp. 71-81.
12. Eric Sloan, *Our Vanishing Landscape* (New York: Ballantine Books, 1974), p. 38.

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SITUATION CARDS

Situation 1

You are consultants for the owner of an ironworks who needs a power source for a stamping plant. The plant will be located in Philadelphia with access to water and rail transportation. While the facility is not large, it will employ 15 workers. The owner hopes to expand the plant.

Situation 2

You are consultants for an owner who wants to build a woolen mill in Harrisville, New Hampshire. It will be located near a stream that can be dammed for a millpond. The stream, although small, has potential for further dams and millponds. The factory will consist of three floors.

The owner will install three sets of machinery for manufacturing woolen cloth such as broad cloth, cassimeres, and black doeskin and has hopes of further expansion. The plant will employ 15 men and 10 women. There is no railroad, although there is talk of getting one sometime in the future. The owner will invest $18,000 in a plant that will have 600 spindles and produce 40,000 yards of cloth annually.

Situation 3

You are consultants for a Southern sawmill owner who wants to build a sawmill along the Savannah River near Savannah, Georgia. The plant will employ about 50 persons and will require about $70,000 of capital investment. The plant will have three vertical saws, four circular saws, and two planing machines and will produce shingles, laths, and lumber.

Situation 4

You are consultants for an owner who wants to construct a gristmill to serve local farmers in an agricultural area in Pennsylvania. The mill will employ around 5 persons.

Situation 5

You are consultants for an owner who wants to build a sawmill in Ohio. The area is being settled rapidly. While the planned facility will be small, employing fewer than 5 persons, the owner hopes to expand the plant.

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DATA PACKET

Item 1

"The motives which have led to the establishment of works at small towns, eight and ten miles from the great points of shipment referred to, have been the lower price of land and the cheaper rate at which employees can live. We think it has been the experience of most manufacturers that more work has been lost by thus isolating themselves than would have many times over paid the interest on increased value of land." (Charles Wilcox, "Iron-Works—Their Location, Arrangement and Construction," *Scientific American*, 15 September 1860, pp. 180-181)

Item 2

"Steampower costs proportionately very much more in small than in large quantities. Independent of this, however, small engines and boilers are much less economical than larger ones, so that the cost of fuel is much larger even at a fixed price per ton." (Charles Emery, "Cost of Steampower," *Transactions—American Society of Civil Engineers*, 1883, p. 430).

Item 3

"The waterfall is rendered available comparatively without labor, and furnishes its supplies without the intervention of human aid. The energies of the steam engine, on the contrary, can be commanded in any situation, only by the influence of the miner; and the localities much removed from sources of fuel, can only be sustained at an expense which falls heavily upon the operations to which they are subservient. That expense, it is true, is continually being diminished, and by means of the steam engine itself, in its character as a carrier; but no happy discovery, no possibility, can reduce it to the minimum at which our water-runs are maintained." (Apppleton's *Dictionary of Machines*, 1852)

Item 4

"For many users waterpower was preferred for its cleanliness and the small space requirements of the equipment, and for freedom from the fire and explosion hazards of steampower, from the dirt and nuisance attending the handling and storage of fuel and ashes, and from the burden and expense of engine and boiler room attendance." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 519)

Item 5

"Waterpower unit costs tended to increase with the size of the plant. Reverse was nearly always the case for steampower." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 519)

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Item 6

"New engines developed after 1850 reduced fuel consumption from 10.0 to 2.5 pounds of coal per horsepower hour. Initial costs of steamplants were down, in part owing to the lower expense of transportation from engine builders. Maintenance and repair costs also decreased." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 487)

Item 7

"In 1854 James B. Francis, Superintendent of Lowell Industries, reported that steampower costs were three times those of water power for Lowell plants. Ten years later he reported the ratio had fallen to two to one, changing only slowly during the succeeding years. Francis declared that 'the highest rates of water power I know of are about half the cost of steam power, say 470 per horsepower per annum'." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine,* 1980, p. 521)

Item 8

"In 1858 Frances wrote that the cost of water power at Lowell ranged from $15-$25 per horsepower per hour, with steam power costs for coal alone in 1863 being 427.90." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine,* 1980, p. 521)

Item 9

" After the Civil War—motive power was but one among many locational factors to be weighted and more commonly than not a minor one—5-10 percent of total production costs. By this time such cost advantages water power still possessed over steam power might readily be overruled by other cost and advantage considerations." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 584)

Item 10

"For a country sawmill operated by men having other duties at times, a simple torrent, dry or nearly so at times during the summer, will answer very well. The farmers' boys can get in their harvest in the dry season, get out and haul logs before the snow melts, and saw them by water power when the stream is full. Everything is of the simplest description; no labor is left idle, and the cost of the whole plant is so small that the mill may be unused for long periods without a loss worthy of consideration.

Such a state of things is not possible with the manufacturing interests of modern times. Large contracts are to be filled; large numbers of operatives are employed, skilled only in particular branches of the particular work done; hundreds of thousands of dollars of capital are invested—the mills cannot be stopped if the owners hope to compete with others doing business in a business way. If the water power fails for a season, steam is employed; and indeed, from its greater reliability, steam is used exclusively in many cases successful competition with waterpowers." (Charles E. Emery, "The Cost of Steam," *Transactions—American Society of Civil Engineers,* 1883, pp. 429-430)

Item 11

A letter from a farmer described the use of small steam engines as follows: "Three hp engine can be drawn by a single horse, 5 hp engine can be drawn by two horses, 8 hp can be used for sawing, pumping, and turn small mill stones. A 5 hp engine consumes about 1/4 cord of wood per day. Wood varies from $2.50-$3.50 per day when purchased." (*Scientific American*, 18 February 1854, p. 184)

Item 12

"Cost of Constructing a Cotton Mill with 4000 spindles. Waterpower Wheel, $1300, Steam Engine, $6000, gearing and belting, $3000; 60 hp needed to turn 4000 spindles. Building 40 x 130 feet and 3 stories high cost $12,000, employed 132 workers." (*Scientific American*, 4 August 1848, p. 365)

Item 13

Letter reports that a 38 hp engine ran 292 days, 10 hours per day, and consumed $5.77 of coal per day or $.15 per hp per day. It had two boilers 30" by 30". It took 8-1/8 pounds of coal to grind one bushel of wheat into flour. Wheat costs around $1.75 per bushel. (*Scientific American*, 17 April 1858, p. 251)

Item 14

Advertisement: "Circular Saw Mill with Engine and Boiler purchased in New York, cost $1500." (*Scientific American*, 30 August 1856, p. 407)

Item 15

Advertisement: "2-1/2 hp engine cost $240, weighs 500 lbs. and is 5 by 3 feet. Boiler is extra." (*Scientific American*, 30 August 1856, p. 407)

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Item 16

By 1850 coal and wood were competitive when burned by locomotives. (Keuchel, "Coal Burning Locomotives: A Technological Development of the 1850's," *Pennsylvania Magazine of History and Biography*, October 1970, p. 486)

Item 17

Letter: "We have put into a grist mill which runs 3 pairs of stones (4 feet diameter) a 25 hp engine with a 20' by 48". It burned 1 bu. coal to grind 10 bu. of what or rye. Some engines consume 50 bu. coal to grind 200 bu. of grain." (*Scientific American*, 1858, p. 208)

Item 18

Advertisements for cost of Engines and Boilers:

"1 hp, $275; 3 hp, $450; 6 hp, $600; 8 hp, boiler was 16' by 30"; 30 hp without boiler, $1037; 10 hp, $1000." (*Scientific American*, 12 July 1856, p. 351)

Item 19

Cost of Operating Steam Engines

	5 hp	25 hp	100hp
Cost, Eng./Boiler	$500	$2000	$9000
Operating/hp/year without coal	$131	$ 37	$ 17
Cost of coal at 44.17 per ton/hp/year	$ 43	$ 30	$ 19

(Adapted from table in Charles Emery, "Cost of Steampower," *Transactions—American Society of Civil Engineers*, 1883, p. 430)

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37. MACHINE AND SOCIAL CHANGE IN INDUSTRIAL AMERICA

Introduction:

Industrialization in 19th-century America was a development in social as well as economic history. Whole patterns of social interaction, attitudes, and values concerning work were being altered by the new industrial system. This moderately structured inquiry-based role-play explores some of these dimensions of social change. The lesson bridges two traditional content areas: industrialization in the North and emergence of a business- and industrial-oriented New South following the Civil War.

Objectives: Students will be able to:

1. Describe changes in work styles and social relationships brought about by industrialization.

2. Gather and analyze data to develop roles.

3. Empathize with people who experienced the effects of industrialization.

Subject/Grade Level: U.S. history/grade 11; economics/grade 12; sociology/grade 12

Time Required: 4-5 class periods

Materials and Preparation: You will need to schedule a day of library research or bring a variety of sources on the post-Civil War South into the classroom. You will also need to make a copy of the Document Packet for each student.

Procedures:

1. Introduce the historical situation that will be simulated by discussing the economic condition of the post-Civil War South—its predominantly rural, agrarian economy and its reliance either upon local, handicraft producers or upon imports from the more industrialized North for manufactured tools. During the course of this discussion, read Henry Grady's statement about the industrial backwardness of the South to the class, explaining that he was the editor of the Atlanta *Constitution* and spokesman for an industrial future for the South:

> A few years ago I told, in a speech, of a burial in Pickens County, Georgia. The grave was dug through solid marble, but the marble headstone came from Vermont. It was in a pine wilderness, but the pine coffin came from Cincinnati. An iron mountain overshadowed it, but the coffin nails and screws and the shovels

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Adapted from *Teaching American History: Structured Inquiry Approaches*, Glen M. Linden and Matthew T. Downey (Boulder, CO: Social Science Education Consortium, 1975). Statement of Henry Grady excerpted from *The New South: Writings and Speeches of Henry Grady*, by Mills Lane, ed. (Savannah, GA: Beehive Press, 1971), pp. 121-22. Reprinted by permission of the publisher.

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> came from Pittsburgh. With hard woods and metals abounding, the corpse was hauled on a wagon from South Bend, Indiana. A hickory grove grew nearby, but the pick and shovel handles came from New York. The cotton shirt on the dead man came from Cincinnati, the coat and breaches from Chicago, the shoes from Boston; the folded hands were encased in white gloves from New York, and round the poor neck, that had worn all its living days the bondage of lost opportunity, was twisted a cheap cravat from Philadelphia. That country, so rich in undeveloped resources, furnished nothing for the funeral except the corpse and the hole in the ground and would probably have imported both of those if it could have done so."

2. Introduce the role-playing situation by explaining that, for the next several days, the class is to imagine that it is meeting in the committee room of a Southern state legislature's Committee on Manufactures. The task of the committee is to consider legislation it might recommend to encourage or discourage manufacturing in the state. That it might want to discourage industrial growth may seem incongruous after the discussion of the Grady quote. In what respects would industrialization not be beneficial? How would the growth of manufacturing affect Southern society? To what extent would a person's role and place in society influence his/her attitude toward industrial development?

3. Ask the students to choose the roles they will assume for the duration of the lesson. Five students should act as members of the Committee on Manufactures and should decide what kind of constituency each is representing as a legislator. They should choose one student as chair of the committee to preside over the meetings. The remainder of the class can develop identities either as (1) Northern men, women, or children who are appearing before the committee as expert witnesses or (2) Southern people who have not yet been greatly affected by economic changes but who are anticipating it. With the assistance of the students, the teacher should develop a list of possible roles and write it on the board. Some possibilities would be:

Unskilled laborers
cotton field hand
dock worker
housekeeper

Semi-skilled workers
machinist
textile mill worker
other factory workers

Business
banker
storeowner
machine shop owner
small manufacturer

Skilled workers
blacksmith
shoe maker
tailor
harness maker
carpenter

Professionals
lawyer
teacher
doctor
clergyman

Agricultural
farmer
sharecropper

4. At the beginning of the second period, which is a preparation period, make available the Document Packet. These are to be considered the written testimony of witnesses unable to attend the committee hearing in person. While the hearing is in progress, the five committee members should initiate a discussion of these materials. This provides an opportunity for the class to consider the views of some 19th-century Americans and to clarify the roles they themselves are assuming. The point should not be missed that the social consequences of industrialization were viewed differently depending upon the person's social position, role, and perspective.

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5. After a day of preparation, the committee should hear testimony of the witnesses present in the classroom. Those students who wish to report orally from the perspective of the role they are playing should do so. The other students will be considered interested spectators, who will submit their reports later in written form.

6. At the end of the testimony, the five-member committee will decide upon its course of action. To focus their discussion, the teacher can list on the board some possible alternatives and solicit others from the class. For example, the Committee on Manufactures might recommend to the legislature that it:

- Provide a state subsidy to manufacturing companies choosing to locate in the state.
- Launch a "sell the state" campaign, advertising the advantages to companies locating there.
- Enact legislation regulating working conditions.
- Try to discourage manufacturing by placing heavy taxation on industrial property.
- Prohibit manufacturing establishments that employ more than ten persons.

Each committee member will explain the policy he/she prefers, given how he/she perceives the social consequences of his action for his/her constituents. Finally, the committee will vote upon one or more recommendations.

It is essential that some time be spent debriefing the role-playing exercise. The students will need to assess the action of the committee members of the previous day. This could lead to a discussion of the importance of political decision making within the process of economic and social change. This will also give the class the opportunity to arrive at some conclusions about the social consequences of industrialization. They should be encouraged to consider the consequences it has had for present-day society and the effect of technological change and economic growth on their own lives. Finally, the teacher may profitably direct the discussion toward the students' values and attitudes regarding social change.

Extension/Enrichment:

Point out that some of the issues related to industrialization are similar to arguments about economic development today. Some states and communities have attempted to limit development in order to protect the environment, while others have felt it necessary to actively seek development in order to gain employment for citizens. Have students research your own state or community's position on development and determine whether they agree or disagree with its position.

DATA PACKET

Document One

Name: Robert S. Howard

Occupation: Textile worker, secretary of local labor union

Date: 1883

"It is a constant race from morning to night after this machinery; and you may know as well as I can tell you, how a man must feel in this hot weather following such an occupation as that. He just feels no manhood about him. He can only take a glass of beer to stimulate him, to give him a little appetite so that he may eat, in order to be able to go through his daily drudgery. I have been there and I know it. From the time I was very young I was fond of reading, and I remember many occasions when I have gone to my supper and taken my daily paper and have fallen asleep with the paper in my hand, and have slept there until about eleven o'clock. Then I have been determined to read it, and have put my lamp beside me when I went to bed, and have gone to sleep again with the paper in my hand and lain there just as I put myself down, without stirring, until morning, the result of exhaustion.

"Now we can never expect advanced civilization among such a number of people until we get a reform of this miserable conditions of affairs."

Source: Excerpted from *Labor and Capital in the Gilded Age* by John A. Garraty. Copyright 1968 © by Little, Brown and Company (Inc.). By permission of Little, Brown and Company.

Document Two

Name: Robert H. Thurston

Occupation: Mechanical engineer

Date: 1880

"Looking back upon our past history, we have seen the growth of our cotton manufactures, from the small beginning of Samuel Slater, and his humble rivals in a New England village, grown, until today many mills of forty thousand spindles each have been built, and the hum of their machinery and the clatter of their shuttles make music in the ears of two hundred thousand thrifty and happy working people. From absolute dependence upon Great Britain, we have grown to independence, and now, more than ten millions of spindles, and nearly a quarter of a million looms in our thousand mills supply Canada, South America, and even China annually with millions of dollars worth of goods.

"Our associates have made this country the most prosperous and happy in the world."

Source: Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 27. Reprinted by permission of Doubleday.

Document Three

Name: John Morrison

Occupation: Machinist in New York City machine shop

Date: 1883

"When I first went to learn the trade a machinist considered himself more than the average workingman; in fact he did not like to be called a workingman. He liked to be called a mechanic. Today he recognizes the fact that he is simply a laborer the same as the others. Ten years ago even he considered himself a little above the average workingman; he thought himself a mechanic, and felt he belonged in the middle class; but today he recognizes the fact that he is simply the same as any other ordinary laborer, no more and no less...."

Questioner: "Dividing the public, as is commonly done, into upper, middle, and lower classes, to which class would you assign the average workingman of your trade at the time when you entered it, and to which class would you assign him now?"

Morrison: "I now assign them to the lower class. At the time I entered the trade I should assign them as merely hanging on to the middle class; ready to drop out at any time."

Source: Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 276-77. Reprinted by permission of Doubleday.

Document Four

Name: Samuel Gompers

Occupation: Skilled craftsman (cigar maker), labor organizer, and soon to be first president of the American Federation of Labor

Date: 1883

"Yes, sir. They find that employers are no longer—when I speak of employers I speak of them generally—that they are no longer upon the same footing with them that they were on formerly. They find that where a man who may have worked at the bench with them employs one or two hands they and he may have full social intercourse together, but as that man increases his business and employs a larger number of hands they find that his position has been removed so far above that of his old friends that they meet no more socially. Probably they may meet occasionally in the factory, when there will be a passing remark of 'Good morning' or 'Good day'; and then, after a while, the employer fails to see the employees at all; the superintendent does all the business and the employer does not bother himself any more about the men. That is how the position of the two has been changed since both were workingmen at the bench. The difference is considerably greater when the employer and the employee did not know each other before....In most such instances the employees are not known as men at all but are known by numbers—'1', '2', '3', '4', and so on..."

Source: Excerpted from *Labor and Capital in the Gilded Age* by John A. Garraty. Copyright 1968 © by Little, Brown and Company (Inc.). By permission of Little, Brown and Company.

Document Five

Name: R. Herbert Newton

Occupation: Episcopal clergyman and social reformer

Date: 1883

"The whole condition of industrial labor has changed in our century. Contrast the state of such labor a century ago with what it is now. Then the handicraftsman worked in his own home, surrounded by his family, upon a task, all the processes of which he had mastered, giving him thus a sense of interest and price in the work being well and thoroughly done. Now he leaves his home early and returns to it late, working during the day in a huge factory with several hundred other men. The subdivision of labor gives him now only a bit of the whole process to do, where the work is still done by hand, whether it be the making of a shoe or of a piano. He cannot be master of a craft, but only master of a fragment of the craft. He cannot have the pleasure or pride of the old-time workingmen, for he *makes* nothing. He sees no complete product of his skill growing into finished shape in his hands. What zest can there be in this bit of manhood? Steam machinery is slowly taking out of his hands even this fragment of intelligent work, and he is set at feeding and watching the great machine which has been endowed with the brains that once was in the human toiler."

Source: Excerpted from *Labor and Capital in the Gilded Age* by John A. Garraty. Copyright 1968 © by Little, Brown and Company (Inc.). By permission of Little, Brown and Company.

Document Six

Name: Carroll D. Wright

Occupation: Head of Massachusetts Bureau of Labor Statistics

Date: 1883

"I am thoroughly satisfied that the factory has been a wonderful element in our civilization toward its advancement....I know the feeling is that the factory system has more and more tended to degrade labor, because under that system thirty or forty years ago, as established in New England, we employed only American girls from our farm houses, while now we see an entirely different class in our factories; but I fail to find that the class who used to be in factories have gone down; they have stepped up into school teaching, telegraphy, and the higher branches of labor, while their places have been filled by a class that have come up from a lower occupation....By the factory we are constantly opening wider the field of advancement for that class of people who unfortunately stand on the lower round of the industrial ladder—we are bringing them up closer."

Source: Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 52-53. Reprinted by permission of Doubleday.

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38. BAD BLOOD: THE TUSKEGEE STUDY OF UNTREATED SYPHILIS

Introduction:

The Tuskegee Study of Untreated Syphilis, conducted by the U.S. Public Health Service on African-American men from 1932-1972, is the longest nontherapeutic experiment on human beings in medical history. In this lesson, students learn about syphilis, its diagnosis and treatment through history, and about the Tuskegee Study. Students examine the following questions concerning the history and nature of science and technology:

- How do society's values affect the questions scientists ask and the ways in which they seek answers to those questions?
- What are the relationships among race, class, and the conduct and content of scientific research?

Note that this activity requires some student knowledge of U.S. race relations in the early 20th century. Students should be familiar with the pattern of social segregation and unequal access to quality education and the legal system experienced by African-Americans in the post-Reconstruction South.

Objectives: Students will be able to:

1. Explain how syphilis is diagnosed and treated.
2. Describe the Tuskegee Study of Untreated Syphilis.
3. Recognize the influence of societal/cultural values on science.

Subject/Grade Level: Biology/grade 10; U.S. history/grade 11

Time Required: 2-3 class periods

Materials and Preparation: Make copies of Handouts 38-1 through 38-4 for all students. Make enough copies of each Instruction Cards for one-fourth of the class.

Procedures:

1. Tell students they will be spending the next several days examining a medical study conducted in the United States from 1932-1972. Learning about the study will help them decide whether and how society and culture influence the conduct and content of science.

2. Draw a long line on the chalkboard with the following positions at either end:

Developed by Sara Thompson, SSEC, based on information from *Bad Blood: The Tuskegee Syphilis Experiment—A Tragedy of Race and Medicine* (New York: The Free Press, 1981).

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Scientific and medical research is often influenced by prevailing social conditions and attitudes.	Scientific and medical research is free from influence by prevailing social conditions and attitudes.

Open the discussion by presenting the two sides of the issue. Then tell students they are going to express their opinions on the issue by voting with their feet. Ask students who agree with the statement at one end of the continuum to come to the front of the room and stand by the statement; those who agree with the other statement should stand at the other end of the continuum. Those who have positions between the two extremes should position themselves along the line to show their relative disagreement/agreement with the two statements.

Ask for a volunteer near one end of the line to explain his/her position; allow time for someone with the opposing view to respond. Allow students time to respond to each other and change their positions along the continuum. When the comments appear to be winding down, allow students to return to their seats.

3. Ask students to record their thinking about the issue in two or three sentences; direct them to save this writing piece in a notebook so they can reexamine their positions later. Tell students that over the next several class periods they will learn about a medical experiment conducted on African-American men suffering from syphilis. Encourage students to reexamine their position on the continuum as they learn about this experiment.

4. Ask students what they know about syphilis: how it is spread, how it affects the human body, and whether a cure for the disease exists. Record student ideas on the board. Distribute Handout 38-1 and ask students to read the information about the history of the disease and its treatment. After students have completed the reading, have them amend and add any new facts to the information on the board.

5. Distribute Handout 38-2 as a reading assignment or present the information as a short lecture. Use the questions for discussion to check student understanding of the information and to discuss any ethical dilemmas they recognize in the study.

6. Arrange the class into groups of four. Distribute the Instruction Cards so that each group member has a different reading assignment. Each student will read about a person who participated in the Tuskegee Study. Direct students to read about and be able to explain their assigned participant's role in the study.

7. Distribute Handout 38-3; ask students in each group to present to their group members what they learned about a Tuskegee Study participant. As each group member reports, students should record information in their retrieval charts. When groups have finished sharing, ask students to report to the class information about each participant in the Tuskegee Study. Record on the chalkboard or overhead transparency of Handout 38-3.

8. Tell students that their groups will now spend 10 minutes discussing the following real-life scenario:

> In 1969 a panel of medical experts met to decide whether the Tuskegee Study should continue. The experts, all of whom were white Southern doctors, discussed the pros and cons of continuing the study, then reached a decision.

Direct students to talk about the panel discussion with their group members. What might the panelists' arguments for continuing the study have been? Arguments for ending the study? Ask students to come up with possible arguments on both sides of the issue and prepare to present them to the class. Students may post their arguments, or you may ask representatives from each group to present their arguments on both sides of the issue.

9. Tell students that a panel of medical experts did meet in 1969 to determine whether the study should continue. Direct students to read Handout 38-4. Then ask students if they can identify social and cultural influences on the doctors involved in the study that affected the conduct of the study. Record their ideas on the board. Ask students how these societal/cultural influences interrelated with the values of the individual doctors.

10. Return to the continuum from the introductory portion of the lesson. Ask students to vote with their feet on the same issue. Ask students along the continuum to describe their position on the issue now. Did evidence from the Tuskegee Study change their position? If so, what evidence was crucial to their new understanding? If not, why not?

11. Ask students to refer to the statements they wrote in their notebook when this lesson began. Ask them to write their current position on the impact of society and culture on science, including how knowledge of the Tuskegee Study may have influenced their opinion.

Extension/Enrichment:

A 1993 NOVA video program, *The Deadly Deception*, presents a fascinating look at the Tuskegee Study of Untreated Syphilis through the voices and stories of people involved in the study. The video also introduces a play based on the Tuskegee Study, entitled "Miss Evers' Boys." Students will find the NOVA program riveting and chilling after their own study of this medical experiment. The video program is available from Films for the Humanities, 800/257-5126.

To further explore values and their impact on the conduct and content of science, students may do research on medical experiments performed in Nazi concentration camps during World War II, on U.S. medical experiments testing the impact of plutonium on human subjects in the 1940s, on U.S. heart disease studies conducted on men only, or on a host or other historical or recent studies. Students may present information in oral or written reports, role plays, or other forms.

Inform students that because of past problems with medical research on women and minorities, the National Institutes of Health now have guidelines for inclusion of women and minorities in such research. Ask students to consider what kinds of provisions should be included in such guidelines. Some of the key provisions in the guidelines are that:

- Women and minorities must be included in medical research so that gaps in our knowledge of health problems affecting women and minorities do not persist.
- Women and minorities cannot be excluded from medical studies because of cost factors.
- Researchers must actively recruit participants from these groups.
- If preliminary research shows gender or racial/ethnic differences in the effectiveness of treatment, final trials must include sufficient numbers of women and minorities to allow these differences to be analyzed.

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SYPHILIS AND ITS TREATMENT

During the 1880s, the Austrian physician Sigmund Freud began treating patients for mental as well as physical illnesses. Some of his patients suffered from what was then called *dementia paralytica*, a disease in which physical paralysis occurred, followed by insanity. Doctors at the time did not know what caused the disease. No effective treatment existed, and patients who developed the disease generally died in insane asylums.

Doctors did suspect a connection between sexual activity and the onset of *dementia paralytica* later in life. Because of the suspected connection with sexual activity, the disease was given the name syphilis, after a young shepherd in a 16th-century love poem.

In 1905, two German scientists identified the microbe that causes syphilis, the bacterium *Treponema pallidum*. This spiral-shaped bacterium could be cultured from blood samples of infected patients. Doctors learned that the disease is transmitted when the bacteria are passed from one person to another through skin contact with an infected sore or chancre or through sexual contact. It may also be passed from mother to fetus, through the placenta.

Once doctors had a means of detecting who was infected with *Treponema pallidum*, they could recognize three stages of the disease, all caused by the same bacterium. The first stage, primary syphilis, occurs within three weeks of infection, when a hard, painful sore called a chancre appears at the site of infection. The chancre disappears within four weeks. Some people infected with the bacteria never develop the chancre. Secondary syphilis occurs two to four months later and is signaled by a skin rash, painful bones and joints, fever, indigestion, and headaches. This second stage of the disease is often followed by a period of latency during which symptoms may disappear altogether. If the disease enters the third or tertiary stage, it can cause rubbery tumors to develop on skin, bones, internal organs, and the central nervous system. Softening of the brain, or neurosyphilis, causes the paralysis and insanity observed by Freud in the 1880s.

By 1910, a scientist named Paul Erlich announced the discovery of a medical treatment that stopped the bacteria from multiplying, preventing the later stages of syphilis. The compound, sold under the name Salvarsan, contained arsenic, which was highly toxic and could cause slow poisoning of the patient. Treatment with Salvarsan required 20 to 40 doses, injected into muscle over the course of a year, to arrest the infection. The treatment was risky and painful.

In the 1940s, penicillin became widely available as a cure for bacterial disease. It proved effective in killing the syphilis bacteria without the risks associated with Salvarsan; because of the widespread use of penicillin as a treatment for syphilis, the rate of syphilis infection quickly dropped to an estimated 20 cases per 100,000 people in the United States.

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THE TUSKEGEE STUDY OF UNTREATED SYPHILIS

In 1972, an Associated Press reporter broke a shocking story: for 40 years, the U.S. Public Health Service (USPHS) had been conducting a study of the effects of untreated syphilis on African-American men in Macon County, Alabama. Over the years of the Tuskegee Study of Untreated Syphilis, named for the educational institution that housed the study in its early years, a variety of tests and medical examinations were performed on 400 men with tertiary syphilis. Investigators tracking the disease in these men wanted to learn about serious complications that developed in the final stage of the disease.

In the study's early years, government doctors provided limited treatment to men enrolled in the study. At the time, penicillin was not yet available as a cure for bacterial infections; treatment with an arsenic compound called Salvarsan was offered in a sporadic way. None of the men in the Tuskegee study who received Salvarsan treatment received enough of the compound to cure the disease.

When penicillin became available as a treatment for syphilis, it was not offered to the Tuskegee patients. In fact, men enrolled in the study were carefully monitored by the project's head nurse, Eunice Rivers, and by local doctors, to ensure that they received no treatment for syphilis.

Over the course of the study, many of the men died of syphilis. Those who didn't die from the disease and lived to describe their experience said that they never understood what the study was about, but they believed they were being treated for "bad blood."

Questions for Discussion:

1. Based on your knowledge of tertiary syphilis, describe the symptoms men enrolled in the Tuskegee Study might have been suffering during the years of the study.
2. Why do you think the study was conducted on African-American men?
3. How might information obtained from the Tuskegee Study have benefitted society? List any possible benefits you can think of.
4. Can you think of any ethical questions that might have arisen over the course of the study? If so, what are they?
5. How do you think the government doctors conducting the study might have dealt with such ethical questions?

RETRIEVAL CHART

As group members describe their participants in the Tuskegee Study, fill in any information you learn about them.

Participants	Education and Background	Attitude toward PHS Doctors	Attitude toward African-Americans	Role in the Study
PHS Doctor		X		
Nurse Rivers				
African-American Man in Study			X	
Macon County Doctor				

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HISTORICAL AFTERMATH

The Blue Ribbon Panel that met in 1969 decided the Tuskegee Study should continue and that the men enrolled in the study should not receive penicillin to treat their syphilis. Most of the panel members believed that the study had provided important new understandings of the disease and would continue to do so. Some panel members argued that treating the men with penicillin now could cause health problems; only one doctor on the panel argued that the men should be treated. For him, the study raised ethical questions. Unless the men were treated, he warned, the study was sure to be criticized. The same doctor also was disturbed by other panel members' apparent inability to see the men enrolled in the study as human beings. To the majority of the panel, he believed, the men were merely scientific subjects.

Following the panel's decision, the Public Health Service entered the 1970s determined to continue the study until the last subject had died. None of the surviving men in the study received treatment for syphilis through the remaining years of the study.

When the Associated Press broke the story about the Tuskegee Study in 1972, Dr. Merlin Duval, assistant secretary for health and science affairs at the U.S. Department of Health, Education, and Welfare, told reporters he was "shocked and horrified" by the Tuskegee Study. He launched a full investigation into the study, promising a special effort to determine "why the study was permitted to continue past the time when penicillin became the effective drug of choice against the disease."

Duvall appointed a nine-member citizens' panel, five of whom were African-American, to investigate the Tuskegee Study. Its first report, issued in late April 1973, was highly critical of the entire study. The panel determined that the experiment was "ethically unjustified in 1932," because it failed to obtain the informed consent of participants in a study of a disease with a known risk to human life. Penicillin, the report stated, should have been made available to the participants as of 1953 when it became widely available. Finally, the panel argued that existing policy related to the use of human subjects in experiments did not provide adequate protection.

Senator Edward Kennedy held hearings on human experimentation in early 1973. Two survivors of the Tuskegee Study, Charles Pollard and Lester Scott, provided the most poignant testimony, unfolding a 40-year saga of lies and deceit, of uneducated men betrayed by government doctors. In the wake of the hearings, the federal government issued completely revamped regulations on human experimentation. For the survivors of the Tuskegee Study, the new regulations came too late. The federal government did promise comprehensive medical care to survivors for the rest of their lives; their families subsequently received medical treatment as well.

In July 1973, Fred Gray, a nationally-known civil rights attorney, filed suit in U.S. District Court for $3 million in damages for each living participant and for heirs of the deceased. In December 1974 the U.S. government settled the case out-of-court: all survivors received a $37,500 cash payment; heirs of deceased participants received $15,000 each.

No PHS doctors who had been directly involved in the study ever admitted any personal wrongdoing; none apologized for their role in the study. Years after the experiment had ended, Nurse Rivers refused to believe it had harmed the men, but she did admit that withholding penicillin from the men in the study may have been an error.

INSTRUCTION CARDS

Public Health Service Doctor

Read the following information about a Public Health Service doctor's involvement in the Tuskegee Study. Be ready to describe his role in the study, his attitudes towards the men being studied, his reasons for conducting the study as he did, and his beliefs about the importance of the study to the medical community.

* * * * *

Dr. Johnson is a Public Health Service doctor, employed by the U.S. government. He grew up in the South and shared many of the attitudes of Southerners in the 1930s towards African-Americans. He followed a long line of Southern physicians who, beginning in the 19th century, sought to prove the physical and mental inferiority of African-Americans in order to justify slavery and, after the Civil War, social segregation. In the early 1930s, Dr. Johnson became interested in determining whether African-Americans are affected differently than whites by syphilis. His hunch was that African-Americans, whom he believed to lack virtue, were more prone to contract this sexually-transmitted disease than were whites and were likely to suffer different manifestations of the disease.

In an initial study in 1933 to determine the number of cases of syphilis among African-Americans in Macon County, Alabama, Dr. Johnson found a high rate of syphilis in the African-American male population there. Realizing that he had a "ready-made opportunity" to study the effect of syphilis on African-Americans, he pushed for an extension of the study. In his new study, he included African-American men who were at least 25 years old and who had had syphilis for at least five years. Dr. Johnson's new study did not include treatment for the disease; in fact, he met with local Macon County doctors to seek their cooperation in not treating the men for syphilis. He was interested in determining the process of the disease in African-American men: how it affects them differently from whites. The new study was open-ended: PHS doctors would follow the progress of the disease in the men until they died.

In the 1940s, when penicillin emerged as a painless and non-hazardous cure for syphilis, Johnson and other PHS doctors did not provide it to the men enrolled in the study. After all, they were interested in studying *untreated* syphilis in these men.

Over the years of the study, as the men died of the disease, PHS doctors were able to perform autopsies and determine how the disease had affected their cardiovascular and central nervous systems, as well as their vital organs. These doctors published numerous articles in medical journals detailing their findings.

When asked about the study, Dr. Johnson was quoted as saying: "We didn't tell the men what was being done. We told them we wanted to test them. They were not told, so far as I know, what they were being treated for or what they were not being treated for." The men "thought they were being treated for rheumatism or bad stomachs....We didn't tell them we were looking for syphilis. I don't think they would have known what that was."

Nurse Rivers

Read the following information about Nurse Rivers's involvement in the Tuskegee Study. Be ready to describe her background, her role in the study, her attitudes towards the men being studied and toward the government doctors for whom she worked.

* * * * *

Nurse Rivers is an African-American woman, born in Macon County, Alabama. She graduated from Tuskegee Institute in 1922 with a degree in nursing. Following graduation, she worked as a public health nurse in the county. In both her schooling and training as a nurse, Rivers learned to respect the doctor and follow his orders. It was her job, she believed, to serve the doctor and not ask questions.

In 1931 Rivers lost her job, but she was recommended for a new position with the Public Health Service (PHS). In this new job, she would assist PHS doctors studying syphilis in African-American males in the county. Rivers eagerly accepted the job. It would be exciting to do important work with government doctors, whom she held in high esteem.

In the early part of the study, Nurse Rivers's role was to drive around the county, picking up men at their homes and bringing them to the hospital for testing. She drove a government-issued car, with a government emblem on it; she got to know the men, and they enjoyed their rides to the hospital with her. She also assisted the doctors in their medical examinations of the men.

As the study continued beyond 1933, Nurse River's role became increasingly important to the PHS. While the PHS rotated a different doctor each year to perform the "annual roundups"—blood and other tests on the men—it was her job to keep the men interested in the study. She was able to do this, in part, by making the men believe they were receiving valuable medical care. It was also her job to prevent the men from seeking treatment for syphilis from local doctors. Many times over the years she intercepted men who sought treatment for the disease, telling the doctors, "he's under study and not to be treated."

Another aspect of her job was to ensure that, when the men died, they would be autopsied. She frequently had to convince widows and other family members to allow doctors to perform autopsies. Beginning in 1935, she was able to offer burial stipends to families in exchange for permission to perform autopsies. She became close to the men and their families over the years of the study and attended funeral services for all those who died. The men liked and trusted the nurse, and called their group a "social club and burial society" and "Miss Rivers' Lodge."

Nurse Rivers's role was vital to the continuation of the study over 40 years. Over the many years of the study, she was the only staff person who remained constant. She served as the glue between the rural African-American men enrolled in the study and the white government doctors.

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Macon County African-American Man Enrolled in the Study

Read the following information about the involvement of an African-American man in the Tuskegee Study. Be ready to describe his background, his attitudes toward the government doctors, understanding of the study, and general health.

* * * * *

Charles Woods was born in Macon County, Alabama. He worked as a sharecropper for a white landowner. Woods and his family and nearly everyone he knew was very poor. He had never received medical treatment in his life prior to the Tuskegee Study; he simply didn't have the money to pay for medical care. Most people he knew could barely get by; he and his family suffered from chronic malnutrition and were frequently sick with one diet-related disease or another. The schools in his county were inadequately funded; most people he knew could neither read nor write.

In the early 1930s, life was especially hard for Woods. The onset of the Great Depression meant jobs were even more difficult to come by. When he heard about an opportunity to enroll in a medical study at the Tuskegee Institute, he saw it as a chance to receive regular medical check-ups and free treatment. After a blood test, the "government doctor" found that he had "bad blood" and that he would be tested periodically for this condition. The doctor gave him some pink pills, which made him feel better.

Besides the check-ups, Woods also received a hot meal on the day of the check-up and a ride in the station wagon with the government emblem driven by Nurse Rivers. His participation in the study gave him a sense of increased status in the community. His participation ensured that his family would be able to afford a funeral service for him upon his death without having to go into debt.

Woods believed that the government doctors who treated him for "bad blood" over the years had his best interests in mind, even though the examinations were often painful. Despite the doctors' care, Woods and others he knew in the study were frequently ill. Some went blind; others became insane. Throughout the years of the study, Woods was never really told what it was all about, but he trusted the doctors to know what was best for him.

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Macon County Doctors

Read the following information about a Macon County doctor's involvement in the Tuskegee Study. Be ready to describe his role in the study, his attitudes towards the men being studied, and his beliefs about the significance of the study to the medical community.

* * * * *

Dr. Shively is a member of the Macon County, Alabama, medical society. He is a white male, raised in the South, and generally in agreement with other white Southerners in his racial attitudes. Namely, Shively believed in the physical and mental inferiority of African-Americans. Still, he provided medical treatment for African-Americans in the county who could afford to pay for his services.

In 1933, Dr. Shively was approached by a Public Health Service doctor about an important syphilis study being conducted in the county. The PHS doctor sought his cooperation in this study: he asked Shively to pledge that he would not treat any of the men enrolled in the study for syphilis. The PHS doctor gave Shively a list of all the men enrolled in the study and asked him to help maintain the death watch over the men: if one of the men on the list was very ill or appeared to be near death, Shively was to alert Nurse Rivers. The nurse would then be able to take the man to the medical facility where he would die and be autopsied.

Flattered by the invitation to participate in a major national scientific study, Shively agreed to cooperate with the government doctors. Neither he nor any of his fellow Macon County doctors questioned whether the study was ethically or scientifically sound.

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39. PREPARING ENVIRONMENTAL IMPACT STATEMENTS

Introduction:

The enacting of the 1970 National Environmental Policy Act (NEPA) set into motion the most far-reaching environmental legislation in U.S. history. In this lesson, students learn about one aspect of that law—the preparation of environmental impact statements.

Objectives: Students will be able to:

1. Describe the purpose of an environmental impact statement and the steps in its preparation.

2. Practice research and questioning skills in preparing an environmental impact statement.

3. Appreciate the role of various scientists in preparing environmental impact statements.

Subject/Grade Level: Civics/grade 9; geography/grades 9-10; economics/grade 12; environmental studies/trades 9-10; biology/grade 10

Time Required: 3 class periods

Materials and Preparation: Read the **Teacher Background Information** and prepare a brief presentation on the material. An overhead transparency of the Picnic Point Beach map would be helpful for the oral presentations. Make one or two copies of Handouts 39-1 and 39-2 for each group of three to five students.

Procedures:

1. Tell students about passage of the NEPA, explaining that this act mandated preparation of environmental impact statements for projects that would affect the environment. Discuss the purpose and process of the EIS.

2. Divide the class into groups of three to five students. Distribute Handout 39-1 and read through it with the students. Tell students that they will be acting as consultants on the Picnic Point Park project. Each team is to develop an EIS from data that will be provided. As a final step, they will present their EIS to a Department of Ecology panel.

3. Distribute Handout 39-2 and allow the balance of the period for teams to work. Some time at the beginning of the next class period should be allowed for completion.

Adapted with permission from Project Learning Tree activity #67, "Impact Statements," American Forest Council, Copyright 1992, *Project Learning Tree Supplementary Activity Guide for Grades 7-12*. The complete activity guide can be obtained by attending a PLT workshop. For more information call the National PLT office at 202/463-2462 or write to PLT, 1111 19th Street, Suite 780, Washington, DC 20036.

4. Begin the hearings by selecting one member from each team to sit on the Department of Ecology panel. Have each group present its findings. Panel members may question the presenters on the accuracy of data and interpretations in the EIS.

5. When all the groups have made their presentations, discuss the presentations as a class, asking such questions as:

- How did the statements differ in their assessment of the significance of the environmental impact, the alternatives they propose, and the evaluation of the short- and long-term benefits of the proposal?
- Did each group consider the impact differently?
- Did you expect all the groups to reach the same conclusion? Why or why not?
- What scientists would contribute to an actual EIS on the proposed project?

Extension/Enrichment:

Students can collect data on proposed local projects or examine impact statements developed on other local projects.

Teacher Background Information:

On January 1, 1970, President Richard M. Nixon signed into law the National Environmental Policy Act (NEPA), the most far-reaching environmental legislation ever enacted. NEPA created a new preventive mechanism for dealing with environmental problems. Section 102 of NEPA requires that all federal agencies prepare a "detailed statement" on "every recommendation or report on proposals or legislation and other federal actions ***significantly*** affecting the quality of the human environment." Specifically, these statements, now known as Environmental Impact Statements (EIS), are required for all projects directly undertaken by federal agencies; supported in whole or in part by federal agencies, contracts, grants, subsidies, loans, or other forms of assistance; or requiring a federal lease, permit, license, or certificate.

Since EISs are intended to assess the impact of a proposed action, a draft statement must be prepared at least 90 days before the proposed action for review by appropriate federal, state, and local agencies as well as the public. Once a statements has been prepared and reviewed, comments received during the review process must be answered. A final statement, incorporating all comments and objections and their resolutions, must then be made public at least 30 days prior to the proposed action.

If any of the reviewing agencies or members of the general public feel that the prepared statement is inadequate, they may file suit to require further research into the project's impact. An EIS's adequacy and completeness is then determined through traditional judicial procedures. If the EIS is found inadequate, it may be revised and resubmitted. If the statement is deemed adequate, the proposed action may proceed. However, if the predicted consequences are seriously detrimental, further litigation may be brought to prohibit the proposed action.

Environmental impact statements are not intended to be justification for proposed funding or action. They are simply detailed presentations of the environmental impacts of and alternatives to the proposed project. The EIS is not intended to screen alternatives solely on the basis of environmental impact. They are prepared to ensure that environmental amenities as well as technical and economic considerations and public desires are equitably considered.

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GUIDELINES FOR PREPARING AN ENVIRONMENTAL IMPACT STATEMENT

I. Description

A. Describe in qualitative and quantitative terms all biological resources and water resources. This discussion should include how the biotic communities have adapted to the physical environment and should also include the hydrologic cycle of adjacent water bodies.

B. Describe the soil characteristics and geology in the project area.

C. Describe all natural resources in the project area, including wilderness areas. The statement should recognize that these wilderness areas are a diminishing resource.

D. Describe existing air quality and any applicable standards or regulations.

E. Include graphic and pictorial information.

F. Describe meteorological conditions in the area.

G. Describe past, present, and proposed land use.

H. Describe accessibility to planning area. Include transportation plans.

I. Describe the socioeconomic situation in the community.

II. Environmental Impacts

A. Discuss impacts that may occur to water quality, air quality, noise, solid waste disposal, and pesticide use.

B. Discuss the impacts the project will have on the physical environment such as soils, geologic formations, hydrology, drainage patterns, etc.

C. Discuss methodology to be used to minimize adverse environmental impacts. Where abatement measures can reduce adverse impacts to an acceptable level, the basis for considering these levels acceptable must be outlined.

D. Discuss the economic impacts of the proposed action.

III. Alternatives

A. Discuss the full range of management alternatives considered in the course of planning the action. The null alternative (the alternative of taking no action) must also be evaluated.

B. Discuss why the proposed alternative was chosen.

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C. Discuss alternatives in sufficient detail so others may realize secondary or long-term environmental impacts.

IV. Short-Term Use Vs. Long-Term Productivity

A. Discuss environmental impact and economic costs and benefits as they relate to short-term uses and long-term productivity.

B. Discuss how actions taken now will (or will not) limit the number of choices left for future generations.

V. Irreversible and Irretrievable Commitment of Resources

A. Discuss resources to be utilized and what the replacement potential of these resources is.

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PICNIC POINT PARK

The Situation

A point of land on nearby Balsam Lake (a federal water impoundment) has been a favorite informal beach for many years. The point is easily accessible, although a railroad track on private property must be crossed to get to the beach. The point has considerable use because it is one of the few public beach areas easily reached by residents of the surrounding area. Last year it received 30,000 visitor-days of use.

After several meetings, the Bureau of Reclamation, which administers the area, has decided that Picnic Point should be proposed as a recreational beach site. An EIS must be submitted because the proposed development will be funded by federal money. Responsibility for preparing the EIS rests with those making the proposal, in this case the Bureau of Reclamation. The EIS will be reviewed at a public hearing held by the Bureau to meet NEPA's requirements.

The Existing Environment

Physical features of Picnic Point include a sandy-gravel beach; a creek running through the park area and emptying into Balsam Lake; and an area graded, but not yet surfaced, for a parking lot.

Biological characteristics to be considered relate to the lake, the land, and the creek. Balsam Lake is a large, quite deep, human-made lake. It is now relatively unpolluted and contains several kinds of fish, with trout the most abundant. However, the water quality is beginning to show some signs of deterioration, possibly because untreated sewage enters the lake from homes and summer cabins on the shore. The lake's edge has algae attached to large pebbles and boulders. This attracts algae-eating animals and their predators. The shallows serve as a breeding area and habitat for several kinds of animals. Water birds also are lake residents.

The land area once was covered with a forest of western red cedar and hemlock. Since these trees were logged off 50 years ago, big leaf maple, red alder, a few Douglas firs, and a wide variety of berry and flowering plants have grown up to cover the site.

Picnic Creek is a fast-flowing stream, not very wide or deep. When it floods, it carries silt from bank cuts, sand, and some larger debris into the lake. The water generally is clear and of high quality except for excess numbers of Coliform bacteria; the bacteria count is two to three times the number safe for human use.

Proposed Park Development

The development of Picnic Point would include these features:

Construction and maintenance of an asphalt parking lot for 48 cars, with a bus stop and turnaround; concrete restrooms; a pedestrian railroad underpass 35 feet long, 10 feet wide, 8 feet high, and 4 feet below the tracks; a picnic area on the sandy land between the beach and the railroad; a gravel fill to protect existing trees along the railroad track; walkways; landscaping for shade and sand and soil stabilization; and settling basin for Picnic Creek located just east of the railroad tracks.

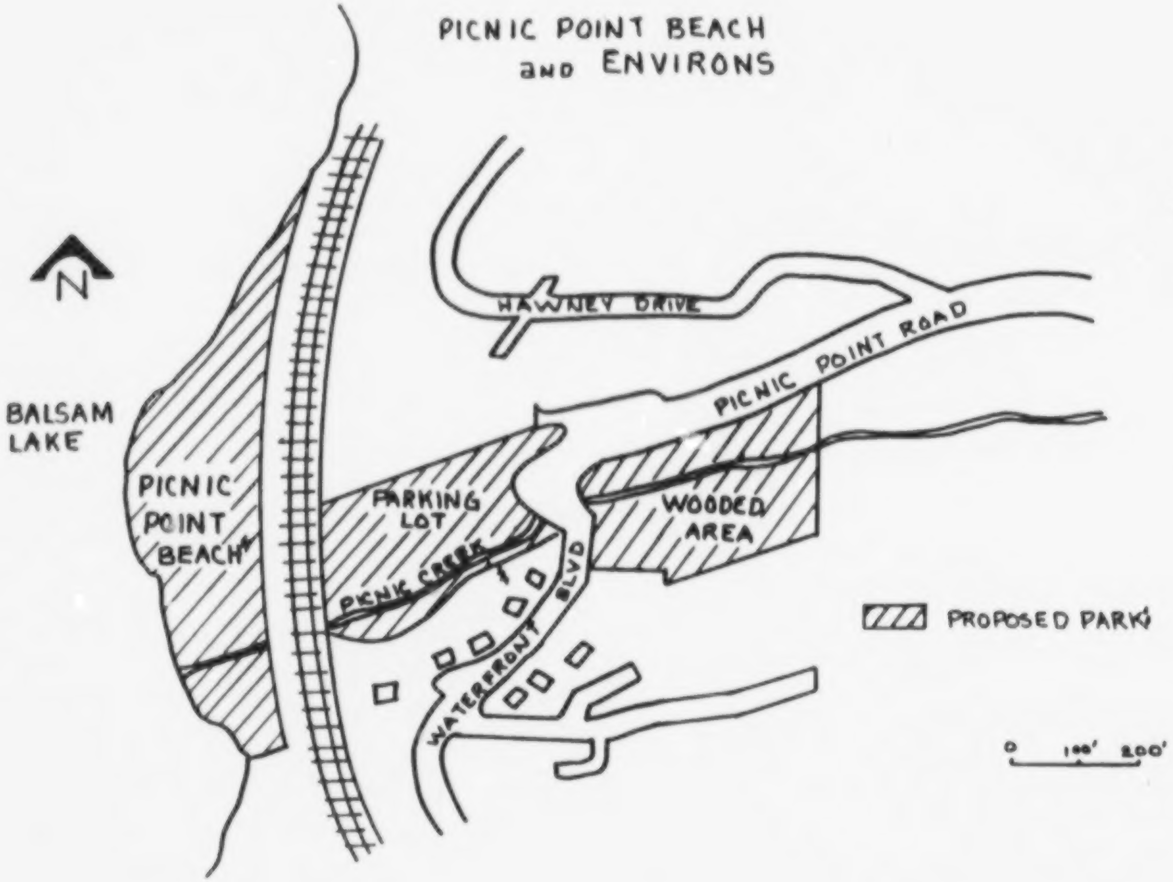
Rules prohibiting camping; horseback riding; motor vehicles; log cutting; fires except in designated facilities; unleased dogs; excessive noise or congregating of groups; pop-open cans; and damage to vegetation, soil, sand, facilities, or native animal life.

Design Considerations

The development must have plans for sewage disposal from restrooms. Ideally this would be accomplished by building a lift station and force main to transfer sewage to the community's new treatment plant now under construction about 3,600 feet from the restroom location.

The design also most allow for sealed catch basins in the parking lot to prevent hydrocarbon run-off into Picnic Creek and consider the flow increment added to the creek by water run-off from the new asphalt parking lot. Although a large flow is not expected, actual data is unavailable.

The development of the beach area is expected to increase its use from about 30,000 visitor-days annually to 47,000. Facilities must be designed to meet the needs of this greater use.


PICNIC POINT BEACH
and ENVIRONS
N
BALSAM LAKE
PICNIC POINT BEACH
PARKING LOT
PICNIC CREEK
HAWNEY DRIVE
PICNIC POINT ROAD
WOODED AREA
WATERFRONT BLVD
▨ PROPOSED PARK
0 100' 200'

40. THE ENVIRONMENT AND PARTICIPATORY DEMOCRACY

Introduction:

Democratic countries are founded on the principle that all citizens have the right to participate in policy-setting and decision-making processes. Civic participation is especially evident in environmental issues and policies. In the United States, there are currently over 10,000 environmental organizations, and new ones are being formed each year.

Young people are not usually involved in setting policies, yet they are greatly affected by the decisions made by governing bodies. For example, each time the local school board meets, it makes decisions that both affect students and determine what school is like for them. Board members might decide whether to adopt a schedule of year-round classes, which textbooks to use, what the requirements will be for graduation, whether to change the length of the school day, or when vacations will be scheduled. Similarly, local, state, and federal governments constantly decide on issues that touch students in many aspects of their lives. Those issues might include health standards, traffic regulations, rules for recycling, or laws about other environmental choices.

Young people can take part in social decisions and policy making in many ways. They can join a group that represents their interests. They can write letters to lawmakers or other influential parties. They might even ask to sit on local boards or councils as student advisors.

Objectives: Students will be able to:

1. Name government agencies and special-interest organizations involved with environmental issues.

2. Understand the process for providing input into public policies.

3. Ask questions to obtain specific information.

4. Value citizen participation.

Subject/Grade Level: Civics/grade 9; government/grade 12; current events/grades 7-12; ecology/grade 9; environmental studies/grades 9-10

Time Required: 3-4 class periods, with time between the first period and subsequent periods to receive information

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Adapted with permission from Project Learning Tree activity #57, "Democracy in Action," American Forest Council, Copyright 1993, 1994, *Project Learning Tree Environmental Education Activity Guide Pre K-8*. The complete activity guide can be obtained by attending a PLT workshop. For more information call the National PLT office at 202/463-2462 or write to PLT, 1111 19th Street, Suite 780, Washington, DC 20036.

Materials and Preparation: Make several copies of Handout 40-1. You will need to have resources available for student use in identifying government agencies and interest groups. Your local telephone directory is a good resource. The blue pages usually list government agencies or departments; the yellow pages list businesses, associations, groups, and clubs; and the white pages list both individuals and organizations. Your local library will have other, more specific directories that list organizations nationally and internationally. You will also need examples of one or more coats of arms to show students. You may want to draw a large coat of arms on the chalkboard or on posting paper.

Procedures:

1. Ask students to jot down a list of five or six things that interest or concern them about the environment. Invite volunteers to share their ideas.

2. Explain to students that they will have an opportunity to learn about groups that have interests or concerns similar to theirs. They will try to find out what issues those groups deal with and how the groups try to influence decision-making processes. Have students look over their lists and circle three items they would like to learn more about.

3. Divide the class into teams of two to four students who have similar interests. To do this, ask a student to share his or her first choice; then ask students with a similar interest to join that student's team. (If no one else is interested in the topic, try the student's second or third choice. If the team becomes larger than four students, divide it into smaller teams.) Continue this process until all students are on a team.

4. Ask each team to find two interest groups, organizations, or agencies that are involved in making decisions about that team's topic. Explain that after teams have located two groups, students are to contact each group's offices to get written information and to ask questions. Give each team two copies of Handout 40-1. If a team finds a local citizens' group, they can contact one of its members to answer the questions.

5. Give students time to brainstorm ideas about starting their search. Have telephone directories available to help students gather ideas and contact sources. If a team can't get started, offer suggestions. For example, if the team is interested in animals, you might suggest that they try the local humane society or the National Wildlife Federation.

6. Allow time for students to contact and question members of their two groups and to receive necessary printed materials.

7. When all teams have completed the student page, give each team two large sheets of paper. Display one or more examples of a coat-of-arms. Ask students what a coat-of-arms is. (It is an emblem that represents the identity of a group.) Assign teams the task of designing two coats-of-arms, one for each group they researched. The coat-of-arms should have six sections, each with a drawing or symbol that represents the group's answers to the questions on the student page.

8. Have teams share the designs and describe what they represent. Lead a discussion on the value of civic action, using the coats-of-arms as a basis for your discussion:

- What similarities did you find in the two groups you researched? What differences?
- How are both groups you researched the same? In what ways do they differ?

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- Why are groups like these important?
- What might happen if either of the groups you researched did not exist?
- In what ways can people take part in policies and decisions in our community? In the state? In the nation?

Extension/Enrichment:

Instead of having teams conduct their own research, invite a local representative from each of several organizations with different perspectives on an environmental issue to speak with your class. The guests might be from groups such as the Audubon Society, Nature Conservancy, Bureau of Land Management, National Association of State Foresters, state forestry associations, an outdoor sports group, or a citizens' group.

Have the class interview the guests by asking questions from Handout 40-1 plus any other questions students think of. (Guests can come on different days or can give a panel presentation.) Afterward, as they answer the questions on the student page, class members should use information and impressions gained from the guests.

Help class members choose an environmental issue or topic about which they would like to learn more. For example, they could choose forests, water, recycling, landfills, endangered species, or a current local topic. Invite representatives of groups with different views to speak to the class about their group's positions on a topic and to answer student questions for each interviewee in advance. After the interviews, use a class discussion to compare the groups' positions on the issue or topic.

GROUP PROFILE

Team's Topic:______________________________

Group's Name: ______________________________

Contact Person:______________________________

Name: ______________________________

Phone Number:______________________________

1. What are the overall goals of the group?

2. What does the group do to influence decision making about the topic? (Examples might include lobbying, making recommendations to lawmakers, or encouraging members to write letters to lawmakers.)

3. What important issue is the group working on right now?

4. What is the group's position on that issue?

5. How is this group different from __________ (other group you're researching on same topic)?

6. How can someone become a member of the group? Are any students members?

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41. FIRST AMENDMENT RIGHTS AND TECHNOLOGY

Introduction:

The focus of this activity is technology and how it is changing the way we think about our constitutional rights. Technological breakthroughs have the potential to interfere with our privacy, improve our health, blight our environment, and provide us with immediate access to information. This lesson asks students to explore new technologies that have raised legal and ethical issues and to develop a plan for using First Amendment rights to advocate a position on one such issue.

Objectives: Students will be able to:

1. Analyze a current policy question created by a scientific breakthrough.

2. Describe the role of the First Amendment in protecting and securing other rights.

3. Develop a strategy for using First Amendment rights to advocate a position on a current technological issue.

Subject/Grade Level: U.S. history/grade 8; civics/grade 9; physical science/grade 9

Time Required: 2 class periods plus research time (research may be done in science class)

Materials and Preparation: You will need copies of Handouts 41-1 and 41-2, as well as materials for making posters.

Procedures:

1. To provide students with a historical perspective on the United States as a nation that values new ideas and technologies, read aloud this excerpt from *Genius of the People*, by Charles L. Mee, Jr. (New York: Harper and Row, 1988); the excerpt describes the library of Ben Franklin:

> To enter the house itself was to step into a world propelled by a delight in the new, the odd, the curious, the bizarre, the funny, the wonderful....The new library was on the second floor, just above the new dining room...In the center of the room was a special writing table, large enough for Franklin to place his large folios of natural history prints on and open them up for his friends to view. He loved to show off, too, a "glass machine" which exhibited the circulation of blood in the arteries and veins of the human body...Another of the marvels in Franklin's study was a long artificial arm and hand that he could use to reach books that were high up on the shelves. The chair in which Franklin usually sat was also of his invention; it was a great armchair, with a rocker, and a large fan above, with which he fanned himself, using only the smallest motion of his foot.

Developed by Jackie Johnson; adapted from *Education for Freedom: Middle School* (Denver, CO: First Amendment Congress, 1991).

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Ask students to speculate on how Franklin's home was different from that of other people of that time.

2. Ask students what inventions they might want to show Franklin if he were to come for a visit. What would he think about some of the technologies? For example, what might he think of a camera that could look inside luggage for weapons? What would he think of government agencies and private companies storing information about citizens in computerized data bases? Would he find such practices to be in conflict with the ideas of the Framers?

3. Provide students with Handout 41-1. Discuss some of the new technologies listed and ask students to add to the list. Explain that you want each of them to explore a particular technology that has raised legal or ethical issues, keeping in mind the ideas about civil liberties that are expressed in the Bill of Rights. Review the directions for the research and presentation of the information in the form of a poster. Point out to students that the last step in the process is planning a strategy for using First Amendment rights to advocate a position on the issues researched. Handout 41-2 can be used as a resource in this planning.

4. Once the posters are completed, have the students analyze the work of the group. What issues seem to be of most concern to the class? Do individuals have different opinions? Do any of the posters cause students to reconsider previously held opinions?

5. Involve students in a plan to "publish" the posters by displaying them in the school. Ask students how the poster display is related to the First Amendment. Why is it important for citizens to have the right to tell others their opinion on such matters? Why is it important that citizens have *informed* opinions? Which of the strategies for using First Amendment Rights are likely to be most effective?

Enrichment/Extension:

Invite several local activists to participate in a panel discussion about how they use First Amendment rights to advance their positions. What strategies are most effective? least effective? difficult to do because of cost or legal restrictions? Although panel members should be asked to focus on use of First Amendment rights rather than on their positions per se, it would still be a good idea to aim for balance among the panelists. If you can locate community members active with respect to the issues students research, that would enhance the activity even more.

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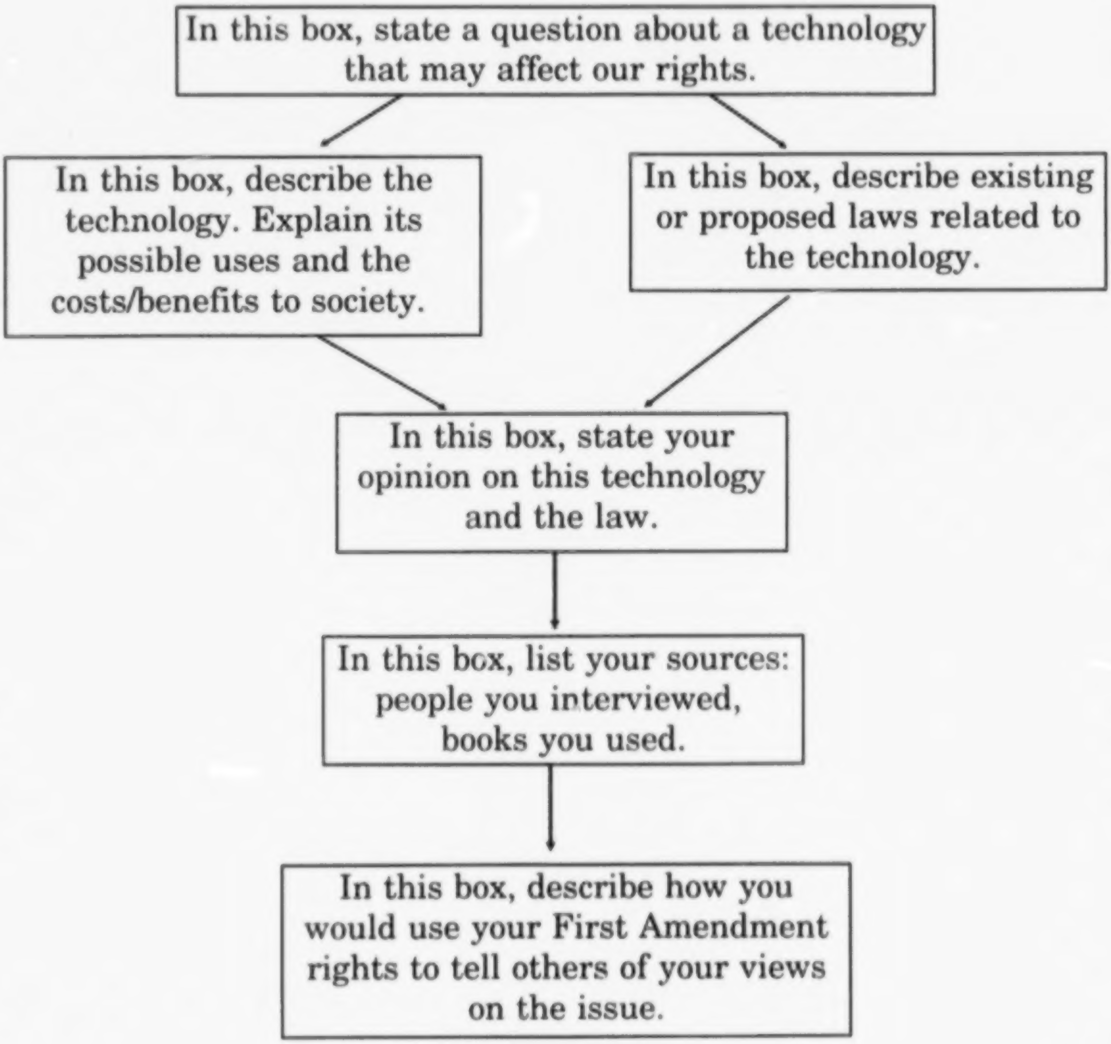
ANALYZING TECHNOLOGY AND LEGAL RIGHTS

Technologies that raise legal questions:

- suicide machine
- surrogate parenting
- drug tests/breathalizer
- use of animals in experiments
- organ transplants
- abortion pill
- DNA/gene testing
- automatic assault weapons


In this box, state a question about a technology that may affect our rights.
In this box, describe the technology. Explain its possible uses and the costs/benefits to society.
In this box, describe existing or proposed laws related to the technology.
In this box, state your opinion on this technology and the law.
In this box, list your sources: people you interviewed, books you used.
In this box, describe how you would use your First Amendment rights to tell others of your views on the issue.

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FIRST AMENDMENT STRATEGY CHECKLIST

Speech

- ☐ Give a speech at a club to which you belong.
- ☐ Talk with friends, family members, and teachers.
- ☐ Stand on a street corner, talking with whomever will listen.

Press

- ☐ Stand on a street corner, passing out handbills.
- ☐ Submit an article to the school newspaper.
- ☐ Write a letter to the editor of the local newspaper.
- ☐ Take out an advertisement in the paper.
- ☐ Ask for public access time to respond to an editorial on TV.
- ☐ Form a new newspaper.
- ☐ Call a press conference.

Assembly

- ☐ Join a club that shares your views.
- ☐ Form a new club of like-minded people.
- ☐ Stage a walkout or sit-in.

Petition

- ☐ Collect signatures of people who agree with you and send them to your representatives.
- ☐ Write letters to public officials.
- ☐ Picket the state capitol.
- ☐ Testify at a city council meeting.

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42. WARNING FUTURE GENERATIONS

Introduction:

Accumulation of nuclear waste products has generated several problems. The problem of how and where to store the materials has been addressed most seriously by the government. The debate on storage methods and locations continues, but a new concern has been raised. Even if storage containers and depositories are developed that are completely safe from the ravages of nature, how can they be made safe from the vagaries of humans?

This exercise asks students to create a sentry system designed to guard nuclear waste dumps from accidental compromise by human actions. The problem of designing a system that will last for 300 human generations will allow students to invent in the areas of linguistics, communication, architecture, art, and science.

Objectives: Students will be able to:

1. Explain the dangers of exposure to nuclear waste.
2. Create a system designed to warn humans of the dangers of exposure to nuclear waste.
3. Develop symbolic languages to communicate the dangers of exposure.
4. Create posters illustrating their physical plans and linguistic inventions.

Subject/Grade Level: Current events/grades 7-12; world geography/grade 7; government/grade 12; environmental studies/grades 9-10

Time Required: 2-4 class periods

Materials and Preparation: Make copies of Handout 42-1 for all students. Gather butcher paper, crayons, markers, dictionaries, and thesauri for use in the small-group work.

Procedures:

1. Divide the class into groups of four. These groups will remain together for the entire project.
2. Distribute Handout 42-1 and allow time for students to read the handout.
3. Answer questions about the assignment. Provide dictionaries and thesauri for reference materials and have students begin. The first day should be spent working on the linguistic aspects of the project.

Developed by Robert D. LaRue, Jr.; from John D. Haas and others, *Teaching About the Future: Tools, Topics, and Issues* (Boulder, CO: Social Science Education Consortium, 1987), pp. 73-76.

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4. During the second period, students should complete work on the linguistic project and begin brainstorming the monolithic aspects of their project. Encourage them to develop plans on scrap paper before moving to the large-scale posters.

5. In the remaining class periods, students should complete work on the posters. Hang the posters and have groups examine and attempt to interpret them. Conduct a discussion of the interpretations and have the class vote on the system that most successfully achieved its objective. During the debriefing, identify and discuss the ideas that worked the best to communicate the desired warnings.

Extension/Enrichment:

You may want to send copies of the most successful design to the school newspaper or to the U.S. Department of Energy.

Advanced classes might want to challenge the idea that warning systems have to follow the parameters provided. Let them explore other possibilities. They might also want to search for solutions to the underlying problem—the generation of nuclear waste—rather than deal with the symptoms.

Classes interested in the linguistic aspects of the project might write heroic legends that would contain warnings about the dangers of entering the disposal areas. These epics must be powerful stories to ensure that they impress the minds of future generations.

Resources:

Didsbury, Howard F., Jr. (ed)., *Communications and the Future* (Washington, DC: World Future Society, 1982).

Douglis, Carole, "Stone Sentry," *Omni*, Volume 8 (November 1985).

Gannes, S., "Sentinels for a Nuclear Tomb," *Discover*, Volume 5 (September 1985).

Herndon, James, *How to Survive in Your Native Land* (New York: Touchstone Books, 1977).

Holden C., "Omens of Doom for Nuclear Waste Tomb," *Science*, Volume 225 (August 3, 1984).

"Nuclear Legends," *Harpers*, Volume 269 (October 1984).

"Warning Signals: How to Warn the 120th Century About Disposal Sites," *Time*, Volume 124 (November 26, 1984).

WARNING FUTURE GENERATIONS

> "How do you talk to the future? Signs rust, documents crumble, buildings fall, languages change. Yet the markers for nuclear waste must warn 300 future generations."
>
> From Carole Douglis, "Stone Sentry," in *Omni*, November 1985, page 64.

Imagine that beneath mounds of earth, acres of radioactive soil have been fused into black glass. Tanks of spent nuclear power plant fuel and high-level defense waste lie buried in deep salt mines. Damage to the protecting layers of earth and salt could release dangerous levels of radioactivity into the ground and the atmosphere. Threats posed by natural disasters have been controlled by careful engineering. The sole remaining challenge to the safety of the depositories is ...humankind.

Radioactive wastes can remain dangerous to life-forms for as long as 3 million years. Even if the physical structures designed to lock in the radiation last that long, how can future generations of curious humans be prevented from penetrating that protection? Warning signs rust away. Books turn to dust. Buildings collapse. Most dangerous of all, languages change.

How can the present communicate such an important message to the future? Researchers have identified four elements essential to an effective long-term warning system:

1. Inanimate objects must communicate a clear and urgent caution.

2. The message must be sent in more than one way: the more redundancy in the system, the lower the margin for error.

3. Warning markers must be of monumental scale. The markers must be made of some massive, hard-to-move chunks of very low-value material. The size and low value prevent the markers from being carted off for other uses. There must be more markers than appear necessary. This will insure that some markers will remain, even if many are destroyed by weather, quakes, war, or other human actions.

4. There must be written records and warnings. The warnings must be understandable even to the illiterate.

While the principles of monumental engineering have been well understood for centuries, the dynamics of languages are more difficult. Studies show that languages change over time. About 19 percent of the basic words of any language change every 1,000 years. After 5,000 years English readers would understand only about half of today's common words. In 10,000 years the percentage drops to about 12 percent. The problem is to construct warning signs that will continue to communicate the DANGER! message in ways that will not lose their meaning with the passage of time.

Your team has been selected to design the nuclear hazard warning system for the United States. Read the instructions on the next page carefully!

Instructions for Warning the Future

1. *Create a language that will resist change for 100,000 years. The most effective languages will use simple, clear symbols. These symbols must be understandable to all cultures. Cartoon-like drawings can be very effective.*
    a. You must work with your group to devise a simple symbolic language that will be understandable to all people. Begin by generating a list of the words you think will be most important in your signs. Invent two or three different symbols for each word and then decide which best communicates the idea of each word.
    b. Make a dictionary list on notebook paper. This will be turned in with your final packet.
    c. Write *three different* warnings in your symbolic language.
    d. Draw the three warnings on the poster paper.
    e. Hang your poster on the wall. Do not translate your poster for any other team.
2. *Design a system to carry your warnings. Remember to follow the four rules of design on the first page of the handout.*
    a. Design a system of warning monuments to guard the place where radioactive wastes will be stored. Be sure to include the locations of the warnings you have written in your symbolic language.
    b. On the second sheet of poster paper, draw an aerial view of your monuments and a close-up of one of the markers.
    c. Hang your second poster next to your first one.
3. *Examine the posters from the other groups and try to decipher their symbols. Take notes on the systems that were the easiest to understand. What made the system work? Where was it weak? Which system do you think is most likely to last for 100,000 years?*

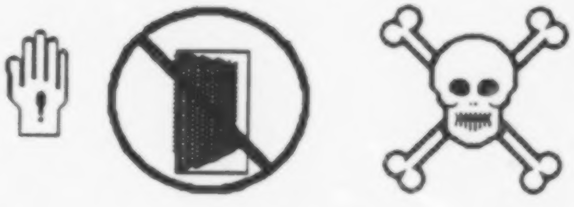
Due Dates: Language Dictionary________________________

Language Poster________________________

Monument Poster________________________

Sample Warning:

What does it say!



43. VIOLENCE AND THE BRAIN: CAN (AND SHOULD) WE FIND THE ROOTS OF AGGRESSION?

Introduction:

Advances in genetics and biotechnology have resulted in a spate of research seeking genetic or biological roots for many kinds of behavior, as well as for diseases. While information about the etiology of behavior can be useful, some people fear that the information could also be used to discriminate against or abuse people. Still others feel that overemphasis on biological causes of behaviors or diseases may result in neglect of social causes or problems.

In this lesson, students are introduced to new research on one behavior—violence. They consider the possible positive and negative uses of information about biological roots of aggressive behavior and make recommendations concerning directions for future research.

Objectives: Students will be able to:

1. Describe new research being done to try to determine the causes of aggressive or violent behavior.

2. Explain how the results of such research could be used to help or hurt people.

3. Take and support a position regarding future directions for research on violence.

Subject/Grade Level: Current events/grades 9-12; government/grade 12; sociology/grade 12; biology/grade 10

Time Required: 2 class periods

Materials and Preparation: You will need copies of Handouts 43-1 and 43-2 for all students. You may want to assign Handout 43-1 as homework the night before you plan to use the lesson.

Procedures:

1. If you did not assign Handout 43-1 as homework, distribute it and allow time for students to read the article in class. Then ask students to free write for three minutes on their response to the article. They can write in any format but should try to continue writing as continuously as possible. The writing period will allow all students to begin developing their thoughts or responses to the article so that discussion will flow more smoothly after the writing period.

Developed by Laurel R. Singleton, SSEC.

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2. Ask students to share some of the ideas that they wrote about (they do not have to read their actual writing). What positive responses did students have to the article? What negative responses did they have? Move from discussing students' personal responses to identifying some pros and cons of research to find biological/genetic roots for aggressive or violent behavior. Post these pros and cons on the chalkboard.

3. Distribute Handout 43-2 and allow time for students to read it. What possible beneficial uses of research information on the roots of aggression does the author identify? What possible negative uses of such information does he mention? If the article suggests or stimulates additional pros and cons, add them to the chalkboard list.

4. Ask the students to count off by threes. Form groups of three students, with a 1, 2, and 3 in each group. All the 1s will take the position that the results of research described in the two handouts suggest that more resources should be put into identifying the biological roots of aggressive behavior and seeking biological remedies for the problem of violence. The 2s will take the position that the best response to the research is to devote more resources to social research or social programs that address the threatening environments that trigger imbalances in genetically susceptible people. In each group of three, the student numbered 1 will have three minutes to make his/her case; the student numbered 3 will then have two minutes to ask questions. This will be followed by three minutes for the argument of student 2, followed by two minutes of questioning by student 3. Student 3 will then announce a decision regarding how resources should be used to follow up on the research reported in the two articles. (If time permits, you can allow students to do additional research to develop support for their positions before they make their presentations in the small group.)

5. Tally the decisions made the students in the groups. Would the class as a whole agree with the majority decision made by the students numbered 3? Students who were assigned to defend a position with which they disagreed will likely want time to explain their true positions, so be sure to allow plenty of time for this discussion.

6. Conclude the lesson by asking students to reflect on how we, as citizens, can make informed decisions about the kinds of scientific research that should be supported and the ways in which the results of that research are used. Allow time for students to write in their journals or complete a second free-writing exercise on this topic.

Extension/Enrichment:

Encourage interested students to read all or part of *Exploding the Gene Myth*, by Ruth Hubbard and Elijah Wald (Boston, MA: Beacon Press, 1993). Pages 104-107 highlight the historic case of the XYY hypothesis, a genotype that some scientists in the 1960s believed was associated with criminality. This hypothesis was widely publicized and prompted calls for screening and counseling programs. The hypothesis was discredited in the 1970s.

Challenge students to find newspaper or magazine articles about other scientific studies that raise ethical issues or issues about how resources should be used. Have them create a bulletin board on "Ethics and Science" that students from other social studies and science classes can examine.

SCIENTISTS TRACING ROOTS OF AGGRESSION

Discoveries Producing Some Ominous Results

by Ronald Kotulak

In probing the biology of violence, scientists have found it useful to take an age-old question—Why do some kids turn out bad?—and pose it this way:

What happens inside a developing brain to turn a child into a killer?

Their discoveries are shedding light on the epidemic of violence being inflicted on children and that they are inflicting on others.

Consider the infant brain: Its main job is to figure out the kind of world it will have to live in and what it will have to do to survive.

For millions of American children, the world they encounter is relentlessly menacing and hostile. So, with astounding speed and efficiency, their brains adapt and prepare for battle.

Cells form trillions of new connections that create the chemical pathways of aggression; some chemicals are provided in over-abundance, some are repressed.

How Brain Adapts

What researchers now can tell us with increasing certainty is just how the brain adapts physically to this threatening environment—how abuse, poverty, neglect or sensory deprivation can reset the brain's chemistry in ways that make some genetically vulnerable children more prone to violence.

The research also has produced an unexpected and ominous revelation: Environmentally induced brain changes can become permanent, encoding into genes a propensity for aggression and violence that can last a lifetime.

Scientists also have found that aggression genes, those that raise a person's propensity for violence, may be passed on to new generations. Some researchers believe that the increase in female criminal violence since the 1950s may be an early sign of how the genes of violence already are building up in the population.

"Aggressive or violent behavior has to be explained in part by biology," said Dr. Burr Eichelman, chief of psychiatry at Temple University in Philadelphia. "Even though there are all kinds of social and learned issues that get played out (in violent behavior), they are all superimposed on a biological substrate."

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Using sophisticated imaging devices that can peer inside the brain, scientists have observed how a threatening environment influences the brain's production of two key chemicals implicated in violent aggression: serotonin and noradrenaline.

Serotonin is the brain's key chemical modulator of primitive drives and emotions, including sex, appetite, mood, sleep and aggression.

Noradrenaline is the brain's master alarm switch. It gets turned on when the brain perceives a threat, preparing the mind to deal with impending crises and preparing the body to fight or flee.

When serotonin is low, all of the basic drives that it regulates can burst out of control. But such impulsivity is especially noticeable in aggression, and it is made worse by high noradrenaline, which ignites the primitive drives.

At the University of Illinois Medical School in Chicago, researchers are examining the blood of children for low serotonin levels. They know from an earlier study that these children are likely to grow up to be troublemakers and they want to find out why.

Studying Serotonin Levels

The study is designed to find out at what point in childhood serotonin levels plummet and what things in a child's early experiences cause serotonin to fall, said Dr. Markus Druesi of the university's Institute for Juvenile Research. He did a study of 29 children and adolescents with disruptive behavior disorders.

It found that a low serotonin level was the single most accurate predictor of which youngsters would go on to commit more violent crimes or suicide.

"What we are all beginning to conclude is that the bad environments that more and more children are being exposed to are, indeed, creating an epidemic of violence," Kruesi said.

"Environmental events are really causing molecular changes in the brain...(so that) people are more impulsive," he said. "It is frightening to think that we may be doing some very dreadful things to our children."

VIOLENCE TRIGGERS IN BRAIN LOCATED
Research Reveals Genetic Connection

by Ronald Kotulak

In a startling series of recent breakthroughs, researchers probing the biology of violence have pinpointed how aggression is triggered in the brain—and how it might be prevented.

Underlying the scientific quest is the growing suspicion that society unwittingly may be feeding the nation's growing epidemic of murder, rape and other criminal acts by making childhood more dangerous than ever.

The most profound discovery, so new that parts of it have yet to be published formally in scientific literature, is that genetic defects produce abnormal levels of serotonin and noradrenaline, two potent brain chemicals that researchers successfully have manipulated to make animals more violent.

Several studies also suggest that threatening environments can trigger imbalances in genetically susceptible people, laying the biochemical foundation for a lifetime of violent behavior.

Such ominous trends as the collapse of the family structure, the surge in single parenting, persistent poverty and chronic drug abuse actually can tip brain chemistry into an aggressive mode—an effect once thought impossible.

These and other findings raise the hope that violent behavior eventually can be curbed by manipulating the chemical and genetic keys to aggression.

The findings also raise fears.

The link between brain chemistry and violence "is extremely interesting and fascinating," said Marie Asberg, chief of neuroscience at the Karolinska Hospital in Stockholm, Sweden. "But it's also a bit dangerous."

"It's the power in it," she explained. "If we know the biology of how aggression works, we might also be able to manipulate it in ways that we don't like. We don't want to stigmatize people as aggressive...because of their brain chemistry. But we do want to use it to help them."

The prospect of being able to determine a person's propensity for violence by measuring levels of brain chemicals—and then regulating those levels—raises several ethical issues.

It virtually is certain, for example, that simple screening tests will be developed to determine levels of serotonin and noradrenaline. Anti-violence medications conceivably could be given, perhaps forcibly, to people with abnormal levels.

There also is concern that genetic screening would lead to preventive detention—the jailing of those found to be predisposed genetically to violence.

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Some people reject any suggestion that genes influence behavior, arguing that people aren't slaves to their genes.

This is especially true when genetics and violence are linked. Such an association raises fears that some groups will be stigmatized as violence-prone, even though experts stress that genes linked to aggression are found in all racial and ethnic groups.

The new insights into the biological roots of violence stem from a revolution in molecular biology, the attempt to understand life molecule by molecule.

As the chemical shadows of aggression flit through the corridors of the mind, scientists can spy on them with new imaging techniques that peer inside churning brains and decipher the molecules of thoughts and emotions.

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44. TELEVISION: ISSUES VS. IMAGE

Introduction:

Television is an example of a technology that has had enormous impact on numerous aspects of our culture. This lesson focuses on the medium's effect on political campaigns and public opinion, but students could just as readily study its effects on family life, recreation, attitudes toward violence, attention span, or numerous other factors.

Although television was introduced and marketed primarily as an entertainment medium, it wasn't long before observers began to ponder its effects on the political process. A watershed date in this respect was October 7, 1960, when most pundits agreed that John F. Kennedy clinched the 1960 presidential election by presenting a more positive image in the first presidential television debate than Richard Nixon.

According to recent surveys, television is the primary source of information for two-thirds of the American public and the *only* source for fully half the citizenry. While the precise effects of this factor on the political process are difficult to assess, most media specialists are agreed that the effect cannot be a healthy one. "There is no longer any room for the expository communication of a Thomas Jefferson, Abraham Lincoln, William Jennings Bryan, or Woodrow Wilson," observed John Splaine. "Their acts of communication were language oriented, which requires an evidence-based argument. Arguments are no longer necessary in the television era—images have taken over."

In this lesson, students review some of the unique principles of television as background for undertaking a comparative analysis of an evening news program and a daily newspaper. After sharing their findings with the class and discussing critical viewing skills, they compile a list of suggested guidelines for television coverage of future political campaigns.

Objectives: Students will be able to:

1. Analyze the effects of television on politics and public issues in the United States.
2. Identify skills needed for critical viewing of television.
3. Develop guidelines for television networks to follow in providing election coverage.

Subject/Grade Level: Current events/grades 7-12; civics/grade 9; government/grade 12

Time Required: 2 class periods

Materials and Preparation: You will need copies of Handouts 44-1 and 44-2 for all students.

Adapted from *U.S. History: Seeking New Directions, 1960-1990*, by Roberta J. Leach, Bonnie McCarthy, and John Vacha (Villa Maria, PA: Center for Learning, 1991).

Procedures:

1. Ask students to think about how many hours of television they watch per week. Have them raise their hands and keep them up until a number of hours is said that is beyond what they watch. Begin with one hour per week and raise the hours step-by-step until all hands are lowered. The mini-survey should reveal the impact of television on how students spend their time.

2. Next, ask students to raise their hands if they read a daily newspaper or weekly newsmagazine to keep up with the news. Then ask those who watch a television news show daily to raise their hands. Do more students get news from written sources or from television? Use the **Introduction** to reinforce the influence of television on citizens' understanding of news events.

3. Distribute Handout 44-1 and ask students to complete the questions. Discuss their answers.

4. Assign Handout 44-2 as homework. Begin class the following day by reviewing students' findings and giving them an opportunity to react to their survey.

5. Continue with a brief discussion of the implications of their findings for the presentation of political candidates on television. The following questions might guide the discussion:

- How do the principles of television bias television toward certain types of candidates and against others?
- How does television control what viewers see?
- How are elections affected when television promotes the emotional over the informational or intellectual?
- How do television ratings affect political coverage?
- What skills are necessary for critical television viewing?

6. Divide the class into small groups. Each group is to create a list of five guidelines group members believe television networks should follow to better prepare voters for future elections. Have individual groups share their work. See if the entire class can reach consensus on appropriate standards.

7. Conclude the lesson by asking students to react to the following quotes from Adlai Stevenson, a two-time unsuccessful candidate for president:

> The idea that you can merchandise candidates for high office like breakfast cereal...is, I think, the ultimate indignity for the democratic process.
>
> The people might be better served if a party purchased a half hour of radio and TV silence during which the audience would be asked to think quietly for themselves.

Extension/Enrichment:

Assign students to continue working in their small groups, with each group researching another aspect of television's impact on U.S. culture. Have the groups plan presentations on their research. When all the groups have presented, conduct a whole-group discussion of the impact of television and what people could do to ensure that new technologies do not have widespread negative effects on their culture.

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TELEVISION: ISSUES VS. IMAGE

Professor of Education John Splaine of the University of Maryland has identified eight "television principles" he believes strongly influence political communicators trying to promote political candidates. Read these principles in preparation for an assignment analyzing a network news broadcast and a daily newspaper's coverage of the same day's events. As you consider the principles, cite at least one example of each drawn from your own viewing experience.

1. Television communication must rely on repetition. ______________________

   ____

2. Television communication relies on "sound bites" and "sight bites" that make memorable impressions on audiences.

   ____

3. Television programming is biased toward emotion rather than intellect. ______________________

   ____

4. Political communicators have found it is not what you say on television but how you look when you are saying it.

   ____

5. Television is edited in such a way as to make it ahistorical. ______________________

   ____

6. Television is aliterate and requires no prerequisites such as the abilities to read, write, think, or view critically.

   ____

7. Television favors the simple over the complex. ______________________

   ____

8. Television rewards those who communicate personally. ______________________

   ____

Adapted from John Splaine, "Televised Politics and the 1988 Presidential Election: A Critical View." Prepublished article reprinted with the permission of Dr. Elmer Williams, Editor of the *Georgia Social Science Journal*, and the author.

NEWS ANALYSIS

In preparation for a class discussion on television and newspaper coverage of issues and politics, complete the following analysis of one national nightly news broadcast and the follow-up coverage in the next day's newspaper.

Nightly news: Date:______________________________ Time:__________ Station:______________

1. How many stories were covered? __________

2. How many commercials were there in the program? __________

3. What was the average time devoted to a news story? __________

4. What was the lead story? __________ How much time was devoted to it? __________

5. What was the second story? __________ How much time was devoted to it? __________

6. What was the third story? __________ How much time was devoted to it? __________

7. Did the program have any sound bites? __________ If so, what were they? ______________

    ____

8. Were they any "fuzzy-warm" stories? __________ If so, what were the topics? __________

9. Did some stories seem too short? __________ Too long?______________________

10. Were there stories that did not answer all of your questions on the topic? __________

    If so, which ____

Daily newspaper: Date ________________________ Name of newspaper ______________________

1. Number of stories on front page: International? National? State? Local?

2. What was the lead story? ________________ How long is it? ________________

3. Was it the same as the lead story on the nightly news? __________

4. Were there related stories on the same or subsequent pages? ______ If so, how many? ______

5. How much time did the story get on television? __________

6. Name three items in the paper that were not given on the nightly news.

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45. JUNK SCIENCE AND JURIES

Introduction:

This lesson deals with a current issue that strikes at the very definition of *science*. In 1991, a California appeals court ruled that only scientific research that had been published in a refereed journal could be considered as evidence in court. This decision, which was appealed, created great controversy, since not only is some research later shown to be in error published in refereed journals, but innovative studies that later prove to be major breakthroughs are rejected by such journals. In this lesson, students consider the case on which the court ruled and examine how citizens can distinguish between "good" and "bad" science.

Objectives: Students will be able to:

1. Explain the current controversy over what scientific information should be allowed as evidence in court cases.

2. Give reasons for and against use of publication in a refereed journal as the criterion for accepting scientific evidence.

3. Suggest other criteria for determining whether scientific information is accepted as evidence.

Subject/Grade Level: Current events/grades 9-12; civics/grade 9; government/grade 12; any high school science course

Time Required: 1-2 class periods

Materials and Preparation: You will need copies of Handout 45-1 for all students. You may want to arrange for a science teacher to be present at the end of the lesson to respond to students' criteria for evaluating scientific evidence.

Procedures:

1. Ask students to imagine that they are members of a jury. The plaintiff's argument rests on scientific research. How would the students, as jurors, decide whether the research is valid? Have students work in pairs to come up with some criteria they might use in deciding whether the research is valid. Ask pairs to share their ideas; post all suggestions on the chalkboard.

2. Tell students that this very issue has generated controversy recently. Distribute Handout 45-1 and allow time for students to read it. Conduct a discussion of the case, using the following questions:

- As a member of the jury, how would you feel about the judge's decision to exclude the expert's testimony?
- Do you think the jury could have assessed the validity of the information for itself? Why or why not?

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- Do you agree with the judge that experts will testify to anything if they are paid enough? What are the implications of your opinion for the operation of our legal system? What does this opinion say about our views of scientists and ethics?
- Do you think publication in a refereed journal is a sufficient criterion for deciding whether scientific information is valid? Why or why not?
- Can you think of other circumstances in which criteria for deciding whether scientific information should be considered would be relevant to citizens?

3. Following the discussion, organize students into groups of three or four. Ask each group to create a list of criteria they think courts and citizens should use to decide whether to rely on scientific information in making decisions. They may use the list the class generated at the beginning of the activity as a starting place if they wish.

4. If feasible, have a science teacher present at the end of the lesson to respond to students' criteria from viewpoint of the scientist.

Extension/Enrichment:

Present students with the Supreme Court's ruling in the case and ask them to discuss whether they agree or disagree with the ruling. The case was decided by the Supreme Court on a 7-2 vote in 1993. In the ruling, the Court threw out the Frye rule for determining whether scientific evidence could be allowed in court. The Supreme Court decided that a judge must rule on scientific testimony based not on peer review but on the judge's own evaluation of the science in question. In the words of the court, the judge must decide whether "the reasoning or methodology underlying the testimony is scientifically valid." Many legal experts worry that the ruling will result in a flood of "junk science" being presented to juries, as well as a different standard for expert testimony in every courtroom. Students could look for cases in which scientific evidence is a key factor and track the cases to see what standards various judges establish.

What Is Good Science?

Two California families decided to sue the drug company, Merrell Dow Pharmaceuticals. Why? Their children were born with stunted limbs. They believed the birth defects were due to the mothers' taking Bendectin, a morning-sickness drug made by Merrell Dow.

In 1991 a California appeals court threw out the parents' case, saying that the scientific evidence on which they were relying was "junk science" because it was not "generally accepted." The court equated general acceptance with having been published in a refereed journal. To be published in such a journal, an article must be favorably evaluated by others working in the same general field; this process is called peer review. In making this ruling, the court was applying the long-established "Frye rule" which is based on a 1923 case involving an early version of lie detector tests.

The parents' lawyers appealed, using two basic arguments to challenge the court's definition of what science is acceptable. First, they argue that referred journals often publish studies that are later shown to be wrong. For example, a journal in 1973 published a paper saying that few asbestos workers die from cancer. The study was seriously flawed, in that it was based on causes of death for retired asbestos workers, but many of those who did get cancer died before they had a chance to retire!

In contrast, many ground-breaking studies are at first rejected by people in the field because they fly in the face of what scientists have always believed. For years, the work of botanist Barbara McClintock was ridiculed by others in her field because they did not belief that genes could jump around on chromosomes. This idea was too radically different from what they had always believed for them to accept it readily. In 1983, McClintock won a Nobel prize for that work. The government often makes decisions on the basis of unpublished scientific work, not wanting to wait until the lengthy process of review and publication is completed.

In addition, prejudice can influence the peer review process. A study showed that reviewers were more likely to give a paper a positive evaluation if a well-known scientist was the author; the same paper with an unknown's name attached as author was rated less positively.

The drug company's lawyers argue that courts must have some way of deciding whether juries should hear scientific information. They cite examples in which clearly unfounded claims were used as the basis for lawsuits. For example, a psychic claimed that she lost her powers after having a CAT scan. A physician provided testimony supporting her claim and she was awarded $1 million (the award was later thrown out).

V. RESOURCES

The lists below suggest the variety of resources available in the area of science/technology/society and the range of organizations and projects with interests in the area. Many of the materials listed contain bibliographies of additional materials, and all of the organizations can provide more information about specific or general topics related to the field. These lists are provided simply as starting points for developing your own resource collection in STS and are not intended to be comprehensive.

Materials

Acid Rain and *Global Warming and the Greenhouse Effect* (Berkeley, CA: Lawrence Hall of Science, 1990). 2 guides, each containing 8 interdisciplinary activities.

Balance (Lakeside, CA: Interact, 1987). Simulation of ecological dilemmas.

Biotechnology: Principles and Issues, by David E. Newton (Portland, ME: J. Weston Walch, 1991). Posters and worksheets.

Clone (Lakeside, CA: Interact, 1991). Simulation of a congressional hearing on genetic engineering.

Contemporary Issues, by Donna C. Lavdis, John A. Santoro, and James A. Wasowski (Dubuque, IA: Brown-ROA, 1991). 34 lesson plans, many on STS issues.

Creative Role-Playing Exercises in Science and Technology (Boulder, CO: Social Science Education Consortium, 1989-1990). 3 simulations on AIDS, solid waste, and nuclear waste.

Decisions, Decisions: The Environment (Watertown, MA: Tom Snyder Productions, n.d.). Computer simulation.

EarthAlert: The Active Environmental Game (Culver City, CA: Social Studies School Service, 1990). Board game.

Earth Matters: Studies for Our Global Future, by Pamela Wasserman (New York: Zero Population Growth, 1991). 32 activities linking population growth and other issues.

Ecology Discovery Activities Kit, by Janet R. Galle and Patricia R. Warren (West Nyack, NY: Center for Applied Research in Education, 1989).

Energy 90s: Learning About Science, Technology, and Society (Santa Monica, CA: Enterprise for Education, 1991). Student book and teacher's guide.

Energy, Technology, and Society: The Energy Education Teaching Package for Grades 9-12 (Salt Lake City, UT: National Energy Foundation, 1990). Five-unit interdisciplinary curriculum.

Environmental Education: Teachers Resource Handbook, edited by Richard J. Wilke (Arlington, VA: National Science Teachers Association, 1994). Curriculum guide.

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Environmental Science Activities Kit, by Michael Roa (Arlington, VA: National Science Teachers Association, 1993). Detailed lessons, labs, and worksheets.

Fish Banks, Ltd. (Durham, NH: Laboratory for Interactive Learning, University of New Hampshire, n.d.). Computer simulation

Global Warming Activities for High School: Social Studies (Oakland, CA: Climate Protection Institute, 1990). Booklet containing 12 lesson plans.

Hands-on Environmental Science Activities, by Eugene Kutscher (Annapolis, MD: Alpha Publishing, 1991). Student book and teacher's guide for 40 activity-based lessons on the environment.

Ideas in Conflict (Hudson, WI: GEM Publications, 1990-1994). Series of books on such issues as ecocide and genocide in the forest, reproductive technologies, nuclear waste, and genetic engineering.

Karimian: A Simulation Game on Sustainable Development (Toronto, ON: CUSO Education Department, 1989). Game for 9 to 36 players.

National Science and Technology Week Materials Packet (Washington, DC: National Science Foundation, annual). Lesson plans, posters, brochure for parents on sharing science with children.

Opposing Viewpoints, edited by David L. Bender and Bruno Leone (San Diego, CA: Greenhaven Press, 1990-1994). Series of books on such topics as biomedical ethics, euthanasia, animal rights, space exploration, and AIDS.

Our Only Earth Series, by Linda MacRae-Campbell and Micki McKisson (Tucson, AZ: Zephyr Press, 1990). 7 units on such topics as air pollution, the future of the rainforests, and endangered species.

Project Learning Tree (Washington, DC: American Forest Council, 1988). Environmental education lesson plans.

Real Science, Real Decisions (Arlington, VA: National Science Teachers Association, 1990). Book of thinking activities on ethical dilemmas in science.

Science and Public Policy: Uses and Control of Knowledge, by Laurel R. Singleton (Boulder, CO: Social Science Education Consortium, 1993). Book and teacher's guide on critical questions related to science and public policy.

SimEarth (Culver City, CA: Social Studies School Service, 1990). Computer simulation.

Social Issues Resource Series (Boca Raton, FL: SIRS, annual). Notebooks or CD-ROMs of articles on such topics as population, energy, hunger, AIDS, habitat, and transportation.

Toward Tomorrow (New York: Scholastic, 1989). Reproducible materials on future issues, including technology, biomedicine, and space.

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Organizations

Acid Rain Foundation
1410 Varsity Drive
Raleigh, NC 27606

Adopt-a-Stream Foundation
Box 5558
Everett, WA 98206

Alliance for Environmental Education
9309 Center Street, Suite 101
Manassas, VA 22110

American Association for the Advancement of Science
1333 H Street, NW
Washington, DC 20005

American Chemical Society
1155 16th Street, NW
Washington, DC 20036

American Council for an Energy Efficient Economy
1001 Connecticut Avenue, NW, Suite 535
Washington, DC 20036

American Forest Council
1250 Connecticut Avenue, NW, Suite 320
Washington, DC 20036

American Oceans Campaign
725 Arizona Avenue, Suite 102
Santa Monica, CA 90401

Association of Science-Technology Centers
1025 Vermont Avenue, NW, Suite 500
Washington, DC 20005

Biological Sciences Curriculum Study
Pikes Peak Research Park
5415 Mark Dabling Boulevard
Colorado Springs, CO 80918-3842

CARE
660 First Avenue
New York, NY 10016

Center for Environmental Information
50 West Main Street
Rochester, NY 14614

Center for Marine Conservation
1725 DeSales Street, NW, Suite 500
Washington, DC 20036

Center for Science in the Public Interest
1875 Connecticut Avenue, NW, Suite 300
Washington, DC 20009

Clean Water Action
1320 18th Street, NW
Washington, DC 20036

Climate Protection Institute
5833 Balmorral Drive
Oakland, CA 94619

Coastal Conservation Association
4801 Woodway, Suite 220 West
Houston, TX 77056

Conservation and Renewable Energy Inquiry and Referral Service
Box 8900
Silver Spring, MD 20907

Cousteau Society
870 Greenbrier Circle, Suite 402
Chesapeake, VA 23320

Environmental Defense Fund
1616 P Street, NW
Washington, DC 20077-6048

Hunger Project
1 Madison Avenue
New York, NY 10010

Institute for Food and Development Policy
145 Ninth Street
San Francisco, CA 94102

National Audubon Society
700 Broadway
New York, NY 10003-9501

National Energy Education Development Project
Box 2518
Reston, VA 22090

National Energy Foundation
Resources for Education National Office
5160 Wiley Post Way, Suite 200
Salt Lake City, UT 84116

National Science Teachers Association
1840 Wilson Boulevard
Arlington, VA 22201-3000.

National Wildlife Federation
1400 16th Street, NW
Washington, DC 20036

Nature Conservancy
1815 North Lynn Street
Arlington, VA 22209

North Carolina Museum of Life and Science
Box 15190
Durham, NC 27704

Nuclear Information and Resource Service
1424 16th Street, NW, Suite 601
Washington, DC 20036

Population Institute
110 Maryland Avenue, NE
Washington, DC 20002

Population Reference Bureau
777 14th Street, NW
Washington, DC 20005

Rainforest Action Network
450 Sansome, Suite 700
San Francisco, CA 94111

Sierra Club
730 Polk Street
San Francisco, CA 94109

Smithsonian Institute
1000 Jefferson Drive, SW
Washington, DC 20560

Union of Concerned Scientists
26 Church Street
Cambridge, MA 02238

World Resources Institute
1735 New York Avenue, NW
Washington, DC 20036

Worldwatch Institute
1776 Massachusetts Avenue, NW
Washington, DC 20036

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